FLOW FORCE

Global Only 1. Company
for Professional Fluid solution

Warranty & Optimal Reliability Products for Global Customers

(High Pressure, Performance and Durability)

Accumulator

- **Hydraulic system**
  - Bladder Type (FB Series)
  - Piston Type (FP Series)
  - Diaphragm Type (FLM Series)

UL CE All Class...

FLOWFORCE CO., LTD.

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Manufacturing Innovation Industry 4.0

"First localization of accumulators that **FLOWFORCE** changed customers' attention who relied on imports after 1988. Once again, **FLOWFORCE** will be your successful partner by leading manufacturing innovation industry 4.0"

Top-5 Shared features

1 ■ **Improve performance / durability / safety of hydraulic system**

- **FLOWFORCE** Accumulators are usable for emergency operation(emergency breaking), energy accumulation, pulse absorption, shock absorption, thermal expansion compensation and for protect internal parts in hydraulic system.

2 ■ **Environmental preservation**

- Apply to fuel savings and emission reductions in hydraulic regeneration system(HCU/HPS)

3 ■ **Reduce investment and production operation cost**

- Contribute to the initial investment and operating cost savings through down-sizing of hydraulic pump/motor by utilizing the energy accumulation.

4 ■ **Increase productivity and process innovation**

- Optimizing working cycle & improving mechanical efficiency by storing & discharging of accumulator.

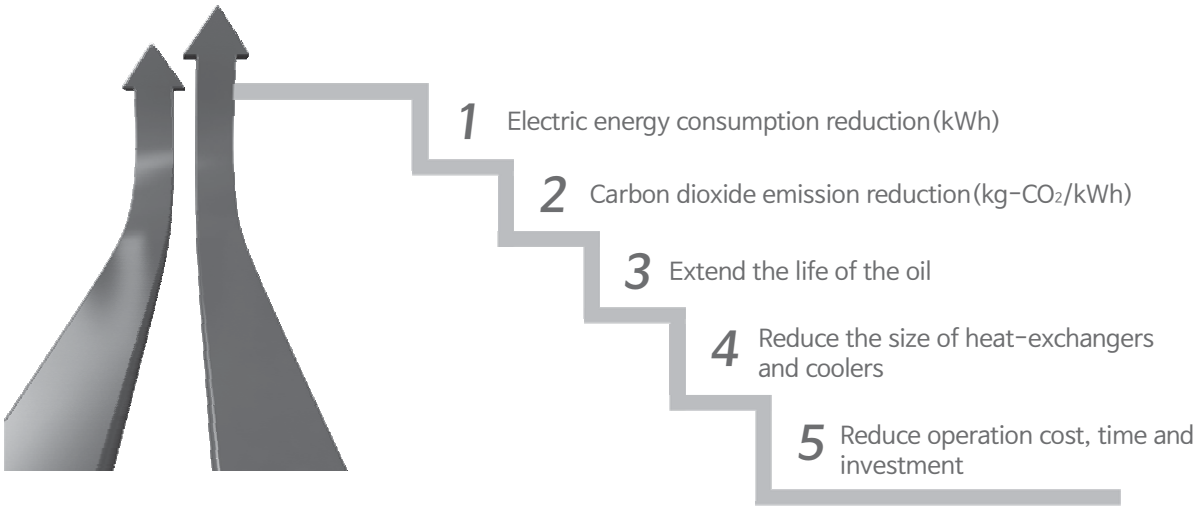
5 ■ **Manufacturing process innovation(Manufacturing Innovation Industry 4.0)**

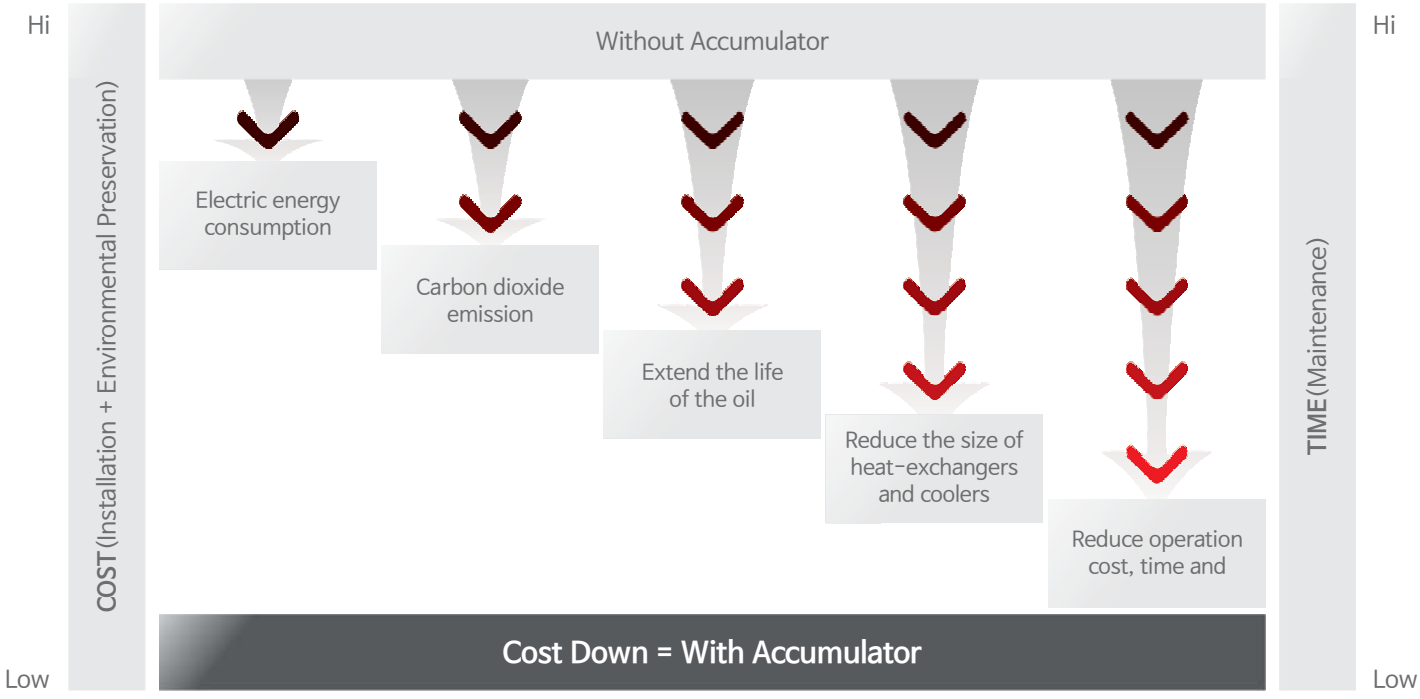
- 3 leading technologies(Configurable, Networkable, Energy-efficient) for next-generation of hydro-power unit that optimize smart function.

Shared features with Accumulators

Using accumulators are the way to contribute to global environmental conservation by saving energy.

Top-5 Benefits with Accumulators



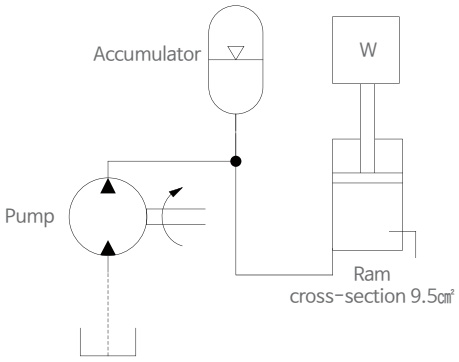


1 Electric energy consumption reduction (kWh)

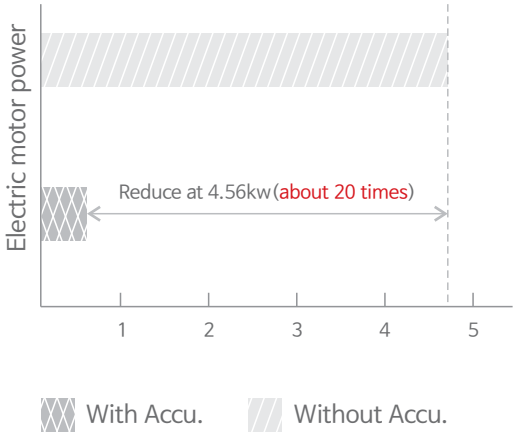
When using accumulators for energy accumulation, the required power of the electric motor driving the pump in the hydraulic system can be reduced about 1/20 compared to when not using the accumulators.

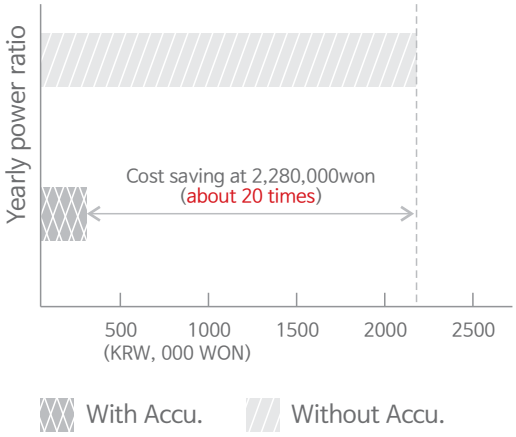
Working Condition

- Ram Load : 9.5 Ton
- Load pressure : 100bar(10MPa)
- Average RPM speed : 5cm/sec
- Stroke : 15cm
- Operating cycle : 0.5/min
- Pump pressure : 200bar(20MPa)



Item		Accumulator	
		With Accumulator	Without Accumulator
Required amount of oil		9.5 ㎠ x 15cm = 1,425㎤ = 1.43 ℓ	
Flow rate per second		9.5 ㎠ x 5cm/sec = 475㎤/s = 0.48 ℓ /sec	
Acc. Required flow	Necessary discharge flow rate of accumulator	= Required amount of oil = 1.43 ℓ	
	Discharge time	$\frac{1.43\,ℓ}{0.48/s}$ = 2.98sec	
	Accumulation time	0.5sec/min = 120sec-2.98sec = 117sec	
	Accumulating flow per second	1.43 ℓ / 117sec = 0.012 ℓ /sec	
Necessary discharge flow of pump		0.012 ℓ /sec	0.48 ℓ /sec
Motor power		0.012 ℓ /sec x 20MPa=0.24kw	0.48 ℓ /sec x 10MPa=4.8kw
Total electric motor power reduction		4.8kw - 0.24kw = 20(4.8kw - 0.24kw = 4.56kw)	
Yearly saving power ratio		4.56kw x 10hr x 250day = 11,400kw x 200won(kw/h) = 2,280,000won	



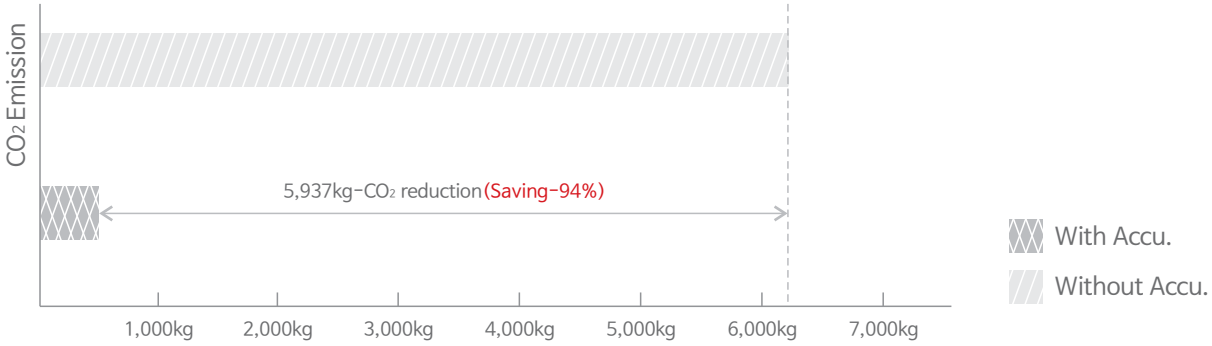


Shared features with Accumulators

2 Carbon dioxide emission reduction

Estimated based on the operating conditions in conjunction with applying the same calculations.

	① With Accumulator	② Without Accumulator
Yearly power consumption (10 hours per day, 250days per year)	0.24kw x 10hr x 250days = 60kw-h	4.56kw x 10hr x 250days = 11,400kw-h
CO_2-kg emission (0.55 kg-CO_2/kwh)	600kw-h x 0.55 = 333kg-CO_2	11,400kw-h x 0.55 = 6,270kg-CO_2
CO_2 emission reduction ratio	1-②/① = 1-333/6,270 x 100 = 94%	



3 Extend the life of the oil

Operating oil life cycle will be reduced every 1℃ raising.
(Optimal oil temperature is about 40˚C but the oil service life will be decreased every 10˚C after the oil temperature at 60˚C)

4 Reduce the size of heat-exchangers and coolers

About 30% of the incoming power(pump) is converted into heat(kcal/h) that loses energy.
Thus, use of accumulators can allow small size of the coolers by reducing heat-exchange rate.

	With Accumulator	Without Accumulator
Heat-exchange rate	0.24kw x 30% = 0.072 kw x 860 = 61.92 kcal/h	4.8kw x 30% = 1.44kw x 860 ≒ 1,280 kcal/h

5 Reduce operation cost, time and investment

- Save more than 50% of the total investment in hydraulic system(Pump 〉 Accumulator)
- **FLOWFORCE** FT-Series(Top repairable) can be able to replace the bladder kit without removing that reduces repairing time by 70% and even save labor cost and time during maintenance.

Certifications & Classifications

Based on ISO9001 & ISO14001 which are quality management & environmental management system that **FLOWFORCE** supplies most of certifications(classification) to comply with the rule of countries and nations.

Available Certifications

Nations

Country/Nation	Classification	Regulation
The European Union	CE Mark	・PED 97/23/EC [Pressure Equipment Directive] ・EN14359:2006
USA / North America	ASME U-Stamp (ASME+CRN)	Code Section VIII Div.1
CHINA	SELO	Special Equipment Licensing Office (To Export)
		[Note] Gas Bottle(KGS approved) / Back-up Nitrogen Bottle for accumulators

Classifications

Classification of institutions (English)	Classification of institutions (Korean)	Regulation
KR	한국 선급협회	Korean Register of Shipping
LR	영국 선급협회	Lloyd`s Register of Shipping
DNV	노르웨이 선급협회	Det Norski Veritas
ABS	미국 선급협회	American Bureau of Shipping/PDA(Product Design Assessment)
BV	프랑스 선급협회	Bureau Veritas
GL	독일 선급협회	Germanicher Lloyd
RINA	이탈리아 선급협회	Rrsistro Italiano Navale
NK	일본 해사협회	Nippon Kaiji Kyokai
CCS	중국 선급협회	China Classification Society
RS	러시아 선급협회	Russian Maritime Register of Shipping

Classifications for Quality & System


CE

ABS

GL

RINA

ISO 9001

ISO 14001

1. Function of Accumulator

Main function

FLOWFORCE Accumulator makes use of the difference in the compressibility of gas(N_2) and a liquid(hydraulic fluid). It is good to be used for hydraulic system, hydraulic equipment and other machinery that utilize fluids can enable the accumulation of pressure.

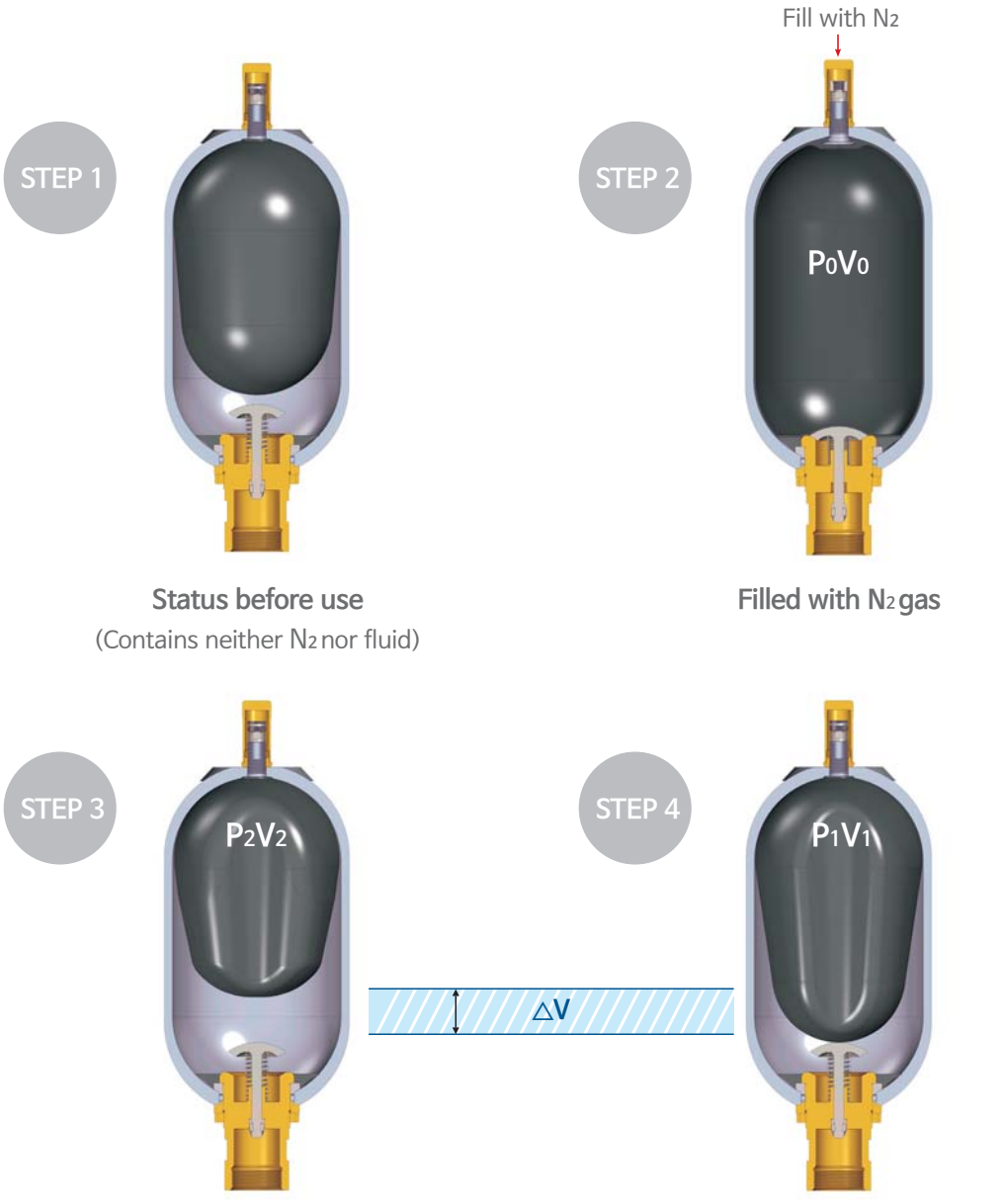
The main functions are

- Storing energy under pressure
- Absorbing hydraulic shock
- Dampening pump pulsation & flow fluctuations
- Improving system efficiency

Working Cycle

$P_0V_0=P_1V_1=P_2V_2=C$

※ Example of Bladder Accumulator



Status before use
(Contains neither N_2 nor fluid)

Filled with N_2 gas

Fluids flows inside

Discharge required of fluid

2. Type & Feature of Accumulator

FLOWFORCE Accumulators can be classified according to the method of separating N_2 gas and hydraulic fluid.

Main Technology by Type

Bladder Type

- Selection of a variety of material & inside coating options
- Covering low to high working temperature from -40℃~120℃
- Quick discharge/response time(Optional as High flow port)
- Variety of media(water/oil)
- Can be installed vertically and horizontally

Diaphragm/Membrane Type

- Compression ratio of 8:1 (P_2/P_0=Max. charging pressure of oil and N_2)
- Can be installed vertically and horizontally
- Welded type : Non-repairable
  Thread type : Bladder repairable
- Compact design
- Quick response

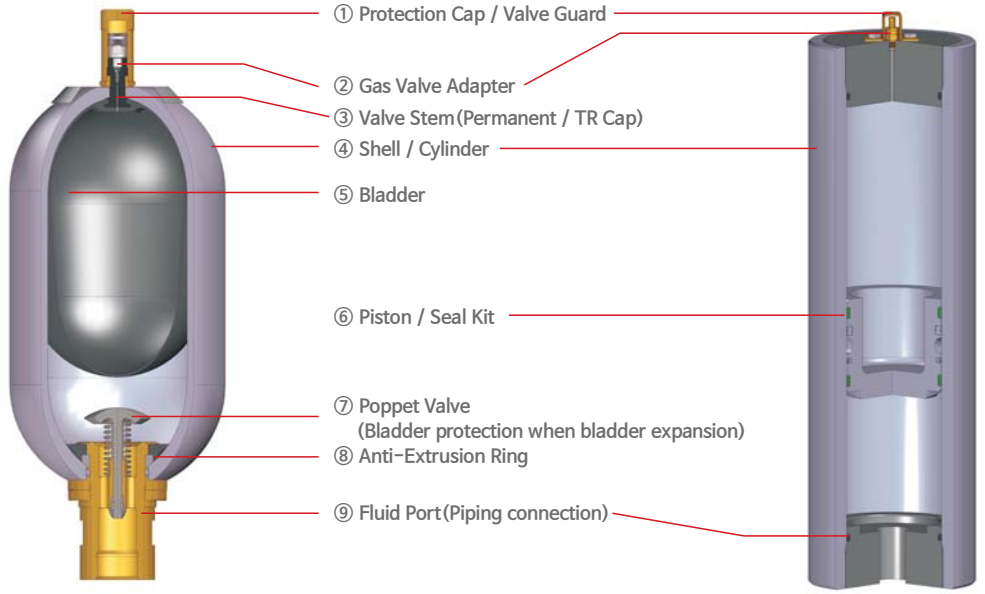
Piston Type

- Measurable Gas volume/pressure
  (Optional Piston Position Indicator)
- Max. compression ratio(P_2/P_0) and Maximize flow of charging/discharging

  (Back-up Nitrogen Bottle for accumulators)
- Available for the customized volume / pressure(up to 1,200bar)

3. Structure of Accumulator

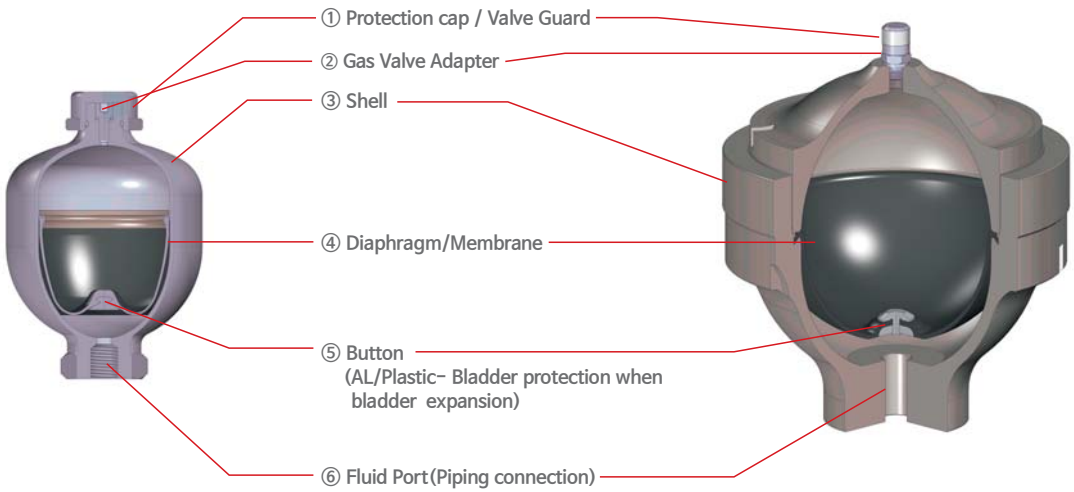
Main parts



Bladder Type

Piston Type

Main parts



Diaphragm / Membrane Type

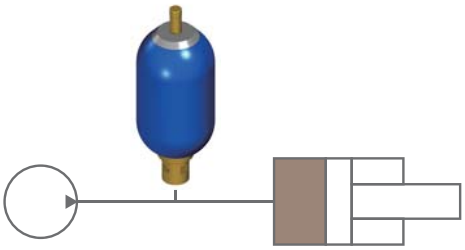
4. Application of Accumulator

1 Energy Accumulation

Accumulators are widely used as a supplementary energy source.
Pressurized and discharged oil from the accumulators are used to operate cylinders enable down-sizing of the pumps, reduce cycle time and converse energy.

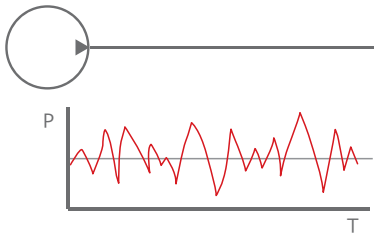
Main application

- Hydraulic press machine
- Die-Casing machine
- Injection molding machine
- Steel mill, chemical and power plant
- Substation circuit breakers
- Vibration test bench
- Water supply system
- Breaking system
- Vessel engine
- Hydraulic power unit



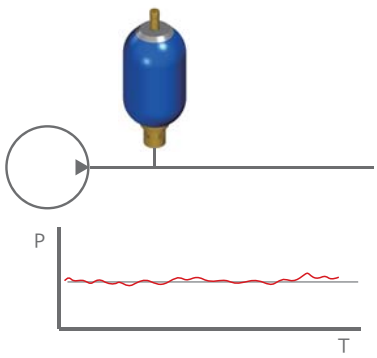
2 Pulse Absorption

There is a pulse from the pump when the pressurized fluid discharged.
Pulse produces noise and vibrations that make the system as instability and the components are being damaged. Using the accumulator can reduce the pulsation and stabilize requested pulsation.



Main application

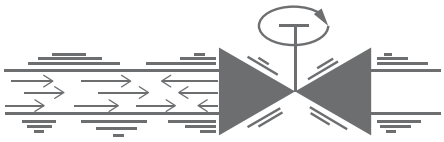
- Machine tools
- Heavy equipment(Breaker, Concrete pump car)
- Hydraulic Elevator
- Water purification system
- Power sprayer
- De-Scaling equipment



4. Application of Accumulator

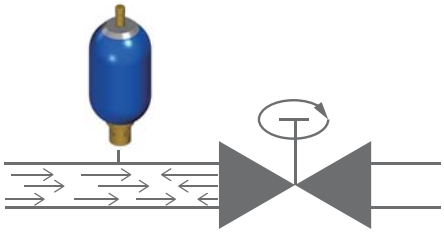
3 Surge Absorption

When rapid closure of valve or sudden load changes in hydraulic system, there is an impact pressure in pipe lines which can lead to noise or damages to pipes or internal parts. The use of accumulators can be reduce such internal shocks.



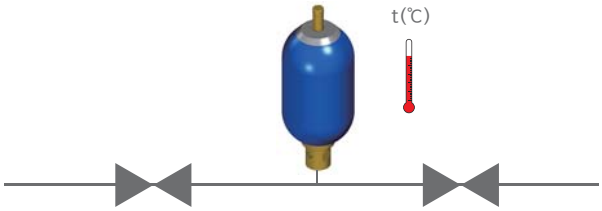
Main application

- Jet fuel injection equipment
- Water pipes
- Wastewater pumping system
- Other pipe lines



4 Thermal Expansion Compensation

Increase or decrease of the internal pressure occurs due to the temperature changes in a closed circuit. It is also one of the accumulator functions that reduce the fluctuations in the pressure.



Main application

- Boilers
- Pressurized water heating system
- Fire extinguishing system
- Central heating system

5 Gas Spring

Accumulator is to be used as a gas spring that enables large load systems to be downsized.

Main application

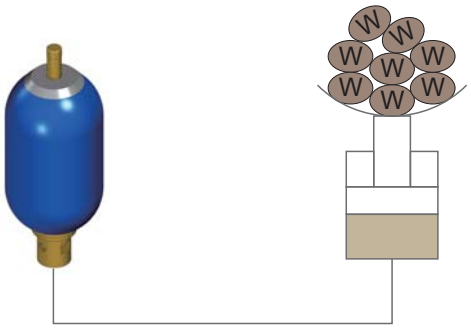
- Vehicle suspension
- Construction equipment
- Agricultural machinery suspension
- Coal mill
- Cement mill
- Con-Crusher machine

6 Equilibrium Action

Accumulators can be used as counter balances that the accumulators smoothly balance the weight or impact of products and machinery

Main application

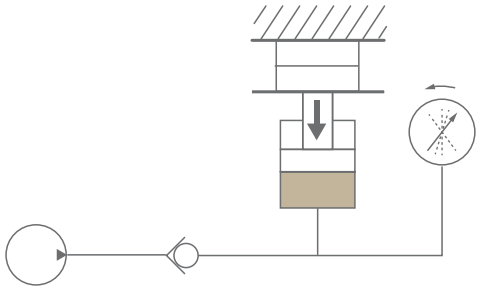
- Large crane
- Large size of machinery tools
- Large hydraulic molding machine

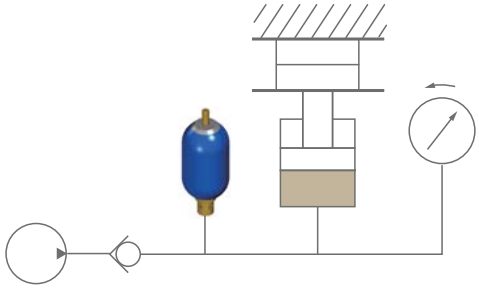


4. Application of Accumulator

7 Leak Compensation

The accumulators can be used for the compensation of any pressure decrease due to internal leakage or during maintenance work.



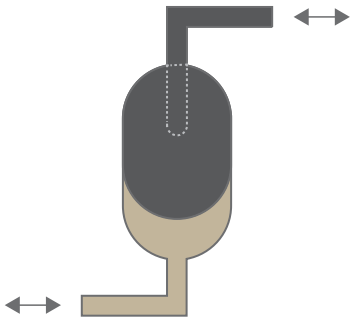


Main application

- Clamping equipment
- Other hydraulic equipment

8 Transfer Barrier

The accumulators are also used as transfer barriers that transfer different type of fluids or gases without mixing.



Main application

- Compressor lubricant supplier
- Booster
- Sealed tanks

5. Selection Procedure of Accumulator

Using the following procedure to choose the appropriate accumulator.

1 Determine the application of accumulator

Choose the application of the accumulator for its intended use.

Example of intended use	Application of Accumulator
· Instantaneous operation of hydraulic cylinders	Energy accumulation
· Reducing the power supplied to a hydraulic press	Energy accumulation
· Prevention damage on devices from pump pulsations	Energy accumulation
· Preventing damage on pipes	Impact absorption
· Preventing damage on devices when a closed circuit at high temperature	Thermal expansion compensation
· Car, crane suspension system	Gas spring
· Small power operation of heavy object	Equilibrium action
· Preventing any loss in pressure due to leakage while pumps are under suspension	Leak compensation
· Compressing high-viscosity lubrication using hydraulic oil	Transfer Barrier

2 Calculation of the required gas volume

★ Refer to page 59. ★

Calculate the required gas volume under the working condition.
Please refer to the calculation sheet on page 59~71 for energy accumulation, pulse absorption, impact absorption and thermal expansion compensation.
※. Please contact **FLOWFORCE** for the sizing program or special applications.

3 Accumulator Model Code

Refer to page 18.

After calculating the required gas volume, please see the following specifications to select the most appropriate accumulators.

Specification & Setting	① Max. working pressure	System pressure or greater
	② Gas volume	Calculated required gas volume or greater
	③ Bladder material	Select the bladder material according to working condition
	④ Max. discharge rate	Necessary rate or greater than flow rate
	⑤ Fluids	Must comply with the fluid used
	⑥ Thread for oil port	Appropriate connectors
	⑦ Specification for gas port	Appropriate connectors

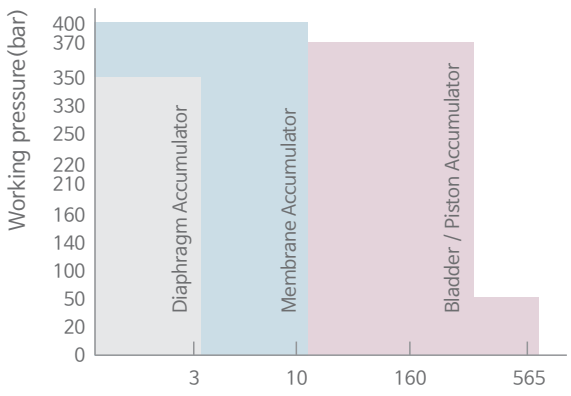
Please contact FLOWFORCE in case you need any following certifications required.

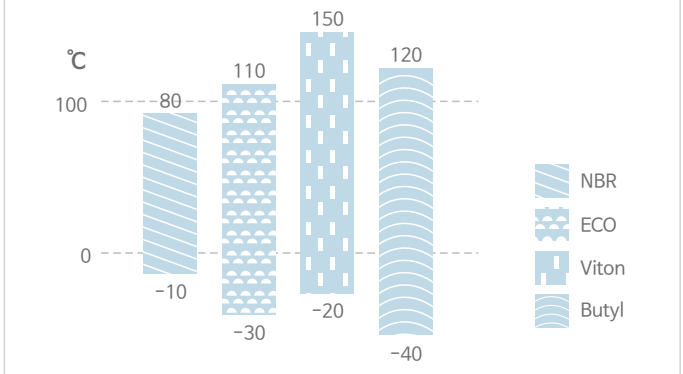
- KGS / Gas Bottle(Back-up Nitrogen Bottle for accumulators)
- SELO
- ASME
- DNV, LR, BV, GL, NK, ABS, KR, RINA, CCS

6. Accumulator Product Range

Table for Max. operating pressure compared to the capacity

Series	Volume (Liter)	Working pressure												
		50	100	160	207	210	220	250	315	330	350	375	400	690
FLM FLMS	0.075							FLM						
	0.16							FLM						
	0.2												FLMS	
	0.32					FLM		FLM						
	0.5					FLM		FLM						
	0.75			FLM		FLM		FLM			FLM			
	1					FLM								
	1.4							FLM			FLM			
	2		FLM					FLM			FLM			
	2.5												FLMS	
	2.8							FLM			FLM			
	3.5							FLM			FLM			
	4												FLMS	
	10												FLMS	
FB FT FH FF FS FP	0.2					FB					FP			
	0.5					FB					FP			
	0.75										FP			
	1						FP				FB, FP	FP		FB
	1.5										FP			
	2						FP				FP	FP		
	2.5										FB, FP			FB
	3										FP			
	4										FP			FB
	5										FP			
	6						FP				FB, FP	FP		
	10			FS	FT,FH		FP			FB, FF		FP		FB
	12									FB				
	12.5													
	20			FS	FT,FH		FP			FB, FF	FP	FP		FB
	24.5									FB, FF				
	30						FP				FP	FP		
	32			FS	FT,FH					FB, FF				FB
	37													
	40						FP				FP	FP		
	42			FS	FT,FH					FB, FF				FB
	50						FP			FB	FP	FP		FB
	57			FS	FT,FH					FB, FF				FB
FT FL FP	60						FP				FP	FP		
	63								FT					
	80						FP		FT		FP	FP		
	100	FL					FP		FT		FP	FP		
	125								FT					
	150	FL					FP				FP	FP		
	160								FT					
	180								FT					
	200	FL							FT					
	300	FL												
	350						FP				FP	FP		
	375	FL												
	475	FL												
	530	FL												
	575	FL												



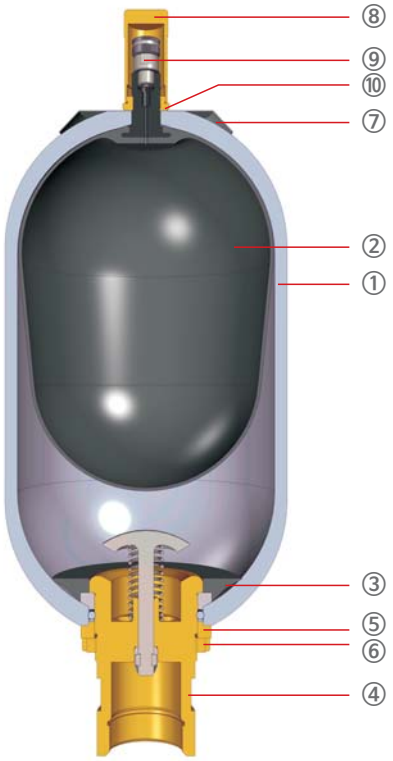


Bladder materials based on working temperature

7. Specification of Bladder Type Accumulator

1 Basic Information

Type / Series	FB, FT, FL, FF, FS
Max. Working Pressure	50 / 330 / 350 / 690 bar
Volume	1~57ℓ, 200ℓ, 575ℓ
Material	Steel, Stainless Steel, Special material
Fluids	· HFC, HLP, HFD · General mineral oil · Phosphate ester · Glycogen · Water emulsion
Working temperature	-40℃ ~ +130℃
Max. flow rate	125 ~ Max.4800ℓ/min
Installation	Vertical / Horizontal
Shell	· Carbon Steel · Stainless Steel · Sand Blast · Primer Coating · Teflon / Nickel coating as an option
Oil Port / Gas Valve Size	· Carbon Steel · Stainless Steel
Fluid Port Size	· PF(Standard) · Flange(SAE) · Special Connection available
Bladder Material	· NBR · Butyl · EPDM · Viton · ECO Bladder
Certification	· PED 97/23 EC · ASME+CRN · ML China · All Class



No.	Parts	Material
1	SHELL	Carbon Steel (Option-Stainless Steel)
2	BLADDER	NBR(Standard)
3	ANTI-EXTRUSION RING	NBR(Standard)
4	FLUID PORT ASS'Y	SCM
5	FLANGE WASHER	S45C
6	LOCKING RING	S45C
7	LABEL METAL	AL
8	PROTECIVE CAP	S45C
9	GAS VALVE	SCM
10	STEM NUT	S45C

※ Above material is our standard for each part but the main parts of FSS series are stainless steel.

7. Specification of Bladder Type Accumulator

2 Ordering Code for Bladder Type Accumulator

①	②		③		④		⑤		⑥		⑦		⑧		⑨		⑩
FB	N	-	330	-	2.5	-	A	-	C25	-	1	-	W	-	100	-	02

① TYPE (Series)

FB	Bottom Repairable Type(Standard)
FT	Top Repairable Type
FL	Large Size Type
FH	High Flow Type
FF	SAE Flange Type
FS	Stainless Type

*Refer to page 20~26.

② Bladder Material

N	Standard Nitrile (Buna-n)
L	Low Temperature Nitrile
H	High Temperature Nitrile
C	Hydrin (ECO)
E	EPDM
B	Butyl
V	Viton (FKM)

*Refer to page 19.

③ Max. Working Pressure

50	50bar
100	100bar
210	210bar
330	330bar
350	350bar
690	690bar

④ Volume(L)

0.05	0.05G/L (0.2Liter)
0.13	0.13G/L (0.5Liter)
0.25	Quart (1Liter)
0.7	0.7G/L (2.5Liter)
1	1G/L (4Liter)
1.5	1.5G/L (6Liter)
2.5	2.5G/L (10Liter)
3	3G/L (12Liter)
5	5G/L (20Liter)
6.5	6.5G/L (24.5Liter)
10	10G/L (32Liter)
11	11G/L (42Liter)
14	14G/L (50Liter)
15	15G/L (57Liter)
16	16G/L (63Liter)
20	20G/L (80Liter)
25	25G/L (100Liter)
32	32G/L (125Liter)
40	40G/L (160Liter)
45	45G/L (180Liter)
50	50G/L (200Liter)

⑤ Gas Port Size

A	1/4"BSP (Standard)
B	5/16"

⑥ Safety Control

Blank	None
C00	*With CPGI
C03	With CPGI (30bar)
C05	With CPGI (50bar)
C10	With CPGI (100bar)
C25	With CPGI (250bar)
T01	*TR CAP (1/4 BSP) Temperature-sensitive
T02	TR CAP (5/8-18UNF)
B01	PBD (270bar) Pressure-sensitive
B02	PBD (Other)

* CPGI(Charging & Permanent Gauge)
TR Cap(Fusible-plug Safety Valve)
BD(Pressure Burst Disc)
Refer to page 51, 52 for CPGI&TR Cap

⑦ Oil Port Size

Blank	Standard
1	NPT 2"
2	1"7/8-UNF
3	SAE 40A 3000PSI
4	SAE 50A 6000PSI
5	MASH M205X3

* Refer to page 42 for bushings

⑧ Fluid

Blank	Oil
W	Water (Nickel Coating)
T	Special (Teflon Coating)

⑨ Parts for Kits

Blank	Complete Accumulator
100	Bladder Kit
200	Shell
300	Oil Port Kit
400	Other Part

⑩ Class/Cert.

Blank	None
01	CE
02	ASME
03	ABS
04	DNV
05	GL
06	LR
07	BV
08	NK
09	RINA
10	SELO
11	Other

3 Order for Bladder Repair Kit

1) Select the model
: FBN 330-5A-100

2) Explanation of above selected model.

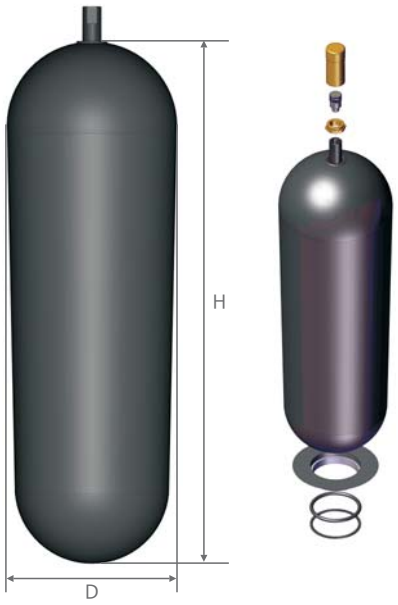
- Type : FB (Bottom repairable type)
- Rubber Materia : NBR
- Max. Working Pressure : 330bar
- Volume :5G/L (20Liter)
- Gas valve size : A
- Parts for Kit : 100 (Bladder Kit)

3) Part list for Bladder Repair Kit

Acc. Side	Gas Valve Parts	Body(shell)	Fluid Port Parts
Kit Component List	Protection cap, Gas valveadapter	Bladder Ass'y(Stem)	· Anti-Extrusion Ring · O-Ring & Back-up Ring

4) Bladder Standard Size

Volume (Gal/Liter)	Dimension	
	H (mm)	D (mm)
0.25 / 1	149	100
0.7 / 2.5	331	100
1 / 4	208	150
1.5 / 6	326	150
2.5 / 10	286	200
3/12	408	200
5 / 20	590	200
6.5 / 24.5	732	200
10 / 32	1114	200
11 / 42	1250	200
14 / 50	1611	200
15 / 57	1733	200

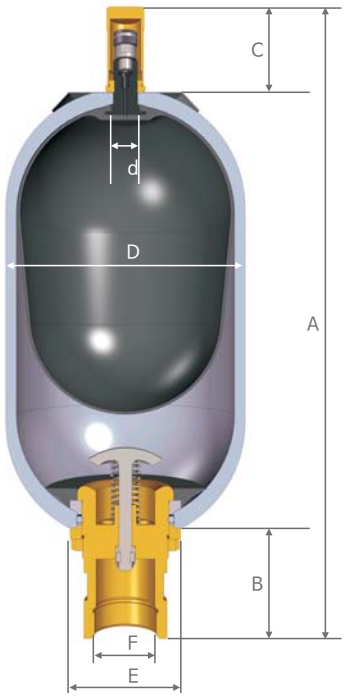


※ Please contact FLOWFORCE for above 60L accumulator.

Code	Bladder Material	Fluid	Working Temperature
N	Buna-n	Petroleum HYD Oil/Water	-15℃ ~ +85℃
L	Low Temperature Nitrile	Petroleum HYD Oil/Water	-28℃ ~ +80℃
H	High Temperature Nitrile	Petroleum HYD Oil/Water	-5℃ ~ +115℃
C	Hydrin (ECO)		-32℃ ~ +115℃
E	EPDM	Phophate Ester Baesd Oil	-40℃ ~ +120℃
B	Butyl	Phophate Ester	-15℃ ~ +120℃
V	Viton (FKM)	Phophate Ester Baesd Oil	-20℃ ~ +130℃

7. Specification of Bladder Type Accumulator

4 FB-Series(Bottom Repairable Type - Standard)



Basic Information

- Max. Working pressure : 330bar(4,800psi), 350bar(5,000psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : CE(AD2000) Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

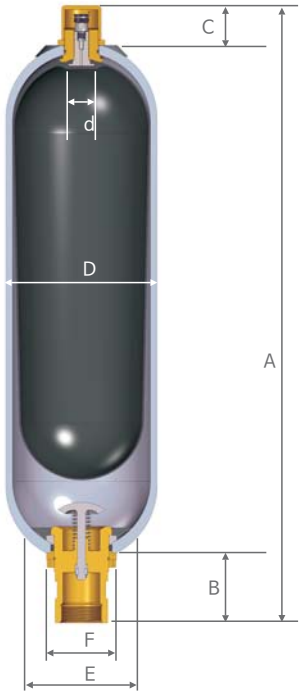
- Please refer to page 18 for more information of N_2 gas charging and control vale.
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +135℃)

Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				Dmax	A max	B	C	Ød	ØE	ØF
FBN-210-0.05A	210/3000	0.05/0.2	95	1.6	51	284	40	47	16	26	1"1/16-12UN
FBN-210-0.13A	210/3000	0.13/0.5	170	3.6	89	265	52	48	16	37	M27x2
FBN-350-0.25A	350/5000	0.25 / 1	240	5	114	328	54	79	22.5	50	PT3/4'
FBN-350-0.7A	350/5000	0.7 / 2.5	450	10	114	548	66	79	22.5	68	G1"1/4
FBN-350-1A	350/5000	1 / 4	450	14	168	433	66	79	22.5	68	G1"1/4
FBN-350-1.5A	350/5000	1.5 / 6	450	20	168	560	66	79	22.5	68	G1"1/4
FBN-330-2.5A	330/4800	2.5 / 10	900	39	219	585	103	79	22.5	101	G2"
FBN-330-3A	330/4800	3 / 12	900	48	219	685	103	79	22.5	101	G2"
FBN-330-5A	330/4800	5 / 20	900	58	219	895	103	79	22.5	101	G2"
FBN-330-6.5A	330/4800	6.5 / 24.5	900	74	219	1030	103	79	22.5	101	G2"
FBN-330-10A	330/4800	10 / 32	900	92	219	1420	103	79	22.5	101	G2"
FBN-330-11A	330/4800	11 / 42	900	114	219	1557	103	79	22.5	101	G2"
FBN-330-14A	330/4800	14 / 50	900	124	219	1943	103	79	22.5	101	G2"
FBN-330-15A	330/4800	15 / 57	900	150	219	2027	103	79	22.5	101	G2"

[Note]

① Tolerance of "A" is ±10mm.
② Please refer to page 42~44 for bushing and flange.

5 FB-Series(Bottom Repairable Type - High Pressure



Basic Information

- Max. Working pressure : 690bar(10,800psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : CE(AD2000) Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Please refer to page 18 for more information of N_2 gas charging and control vale.
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +135℃)

CE Approved

Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				Dmax	A max	B	C	Ød	ØE	ØF
FBN-690-0.25A-01	690/10000	0.25 / 1	240	8	123	364	54	79	22.5	50	PT3/4"
FBN-690-0.7A-01	690/10000	0.7 / 2.5	450	13	123	551	66	79	22.5	68	G1"1/4
FBN-690-1A-01	690/10000	1 / 4	900	19	123	745	66	79	22.5	68	G1"1/4
FBN-690-2.5A-01	690/10000	2.5 / 10	900	48	245	561	103	58	51	101	G2"
FBN-690-5A-01	690/10000	5 / 20	900	83	245	871	103	58	51	101	G2"
FBN-690-10A-01	690/10000	10 / 32	900	143	245	1406	103	58	51	101	G2"
FBN-690-11A-01	690/10000	11 / 42	900	157	245	1536	103	58	51	101	G2"
FBN-690-14A-01	690/10000	14 / 50	900	199	245	1911	103	58	51	101	G2"
FBN-690-15A-01	690/10000	15 / 57	900	208	245	1991	103	58	51	101	G2"

ASME Approved

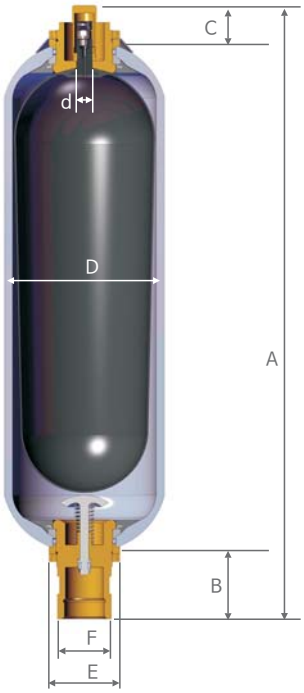
Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				Dmax	A max	B	C	Ød	ØE	ØF
FBN-690-2.5A-02	690/10000	2.5 / 10	900	80	267	580	103	58	51	101	G2"
FBN-690-5A-02	690/10000	5 / 20	900	137	267	898	103	58	51	101	G2"
FBN-690-10A-02	690/10000	10 / 32	900	231	267	1422	103	58	51	101	G2"
FBN-690-11A-02	690/10000	11 / 42	900	255	267	1558	103	58	51	101	G2"
FBN-690-14A-02	690/10000	14 / 50	900	323	267	1936	103	58	51	101	G2"
FBN-690-15A-02	690/10000	15 / 57	900	333	267	1991	103	58	51	101	G2"

[Note]

① Tolerance of "A" is ±10mm.
② Please refer to page 42~44 for bushing and flange.

7. Specification of Bladder Type Accumulator

6 FT-Series(Top Repairable Type)



Basic Information

- Max. Working pressure : 207bar(3,000psi), 315bar(4,500psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : ASME Certificated/SELO Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Please refer to page 18 for more information of N_2 gas charging and control vale.
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +135℃)

Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				Dmax	Amax	B	C	Ød	ØE	ØF
FTN-207-2.5A	207/3000	2.5 / 10	1080	38	228	559	103	62	89	101	G2"
FTN-207-5A	207/3000	5 / 20	1080	60	228	864	103	62	89	101	G2"
FTN-207-10A	207/3000	10 / 32	1080	97	228	1391	103	62	89	101	G2"
FTN-207-11A	207/3000	11 / 42	1080	106	228	1540	103	62	89	101	G2"
FTN-207-15A	207/3000	15 / 57	1080	138	228	1994	103	62	89	101	G2"

SELO Approved

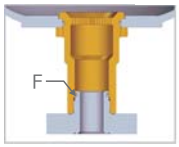
Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				Dmax	Amax	B	C	Ød	ØE	ØF
FTN-315-16A	315/4500	16 / 63	1800	175	351	1152	140	62	130	146	G3"
FTN-315-20A	315/4500	20 / 80	1800	206	351	1377	140	62	130	146	G3"
FTN-315-25A	315/4500	25 / 100	1800	250	351	1642	140	62	130	146	G3"
FTN-315-32A	315/4500	32 / 125	1800	304	351	1972	140	62	130	146	G3"
FTN-315-40A	315/4500	40 / 160	1800	378	351	2432	140	62	130	146	G3"
FTN-315-45A	315/4500	45 / 180	1800	420	351	2682	140	62	130	146	G3"
FTN-315-50A	315/4500	50 / 200	1800	460	351	2962	140	62	130	146	G3"

[Note]

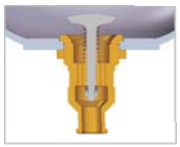
① Tolerance of "A" is ±10mm.
② Please refer to page 42~44 for bushing and flange.

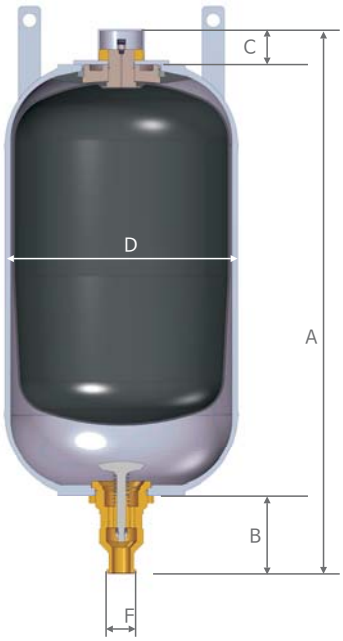
7 FL-Series(Large Volume)

MASH TYPE



SAE FLANGE TYPE





Basic Information

- Max. Working pressure : 50bar (725psi)
- Working temperature (Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃ (-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : ASME Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Please refer to page 18 for more information of N_2 gas charging and control vale.
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +135℃)

SAE FLANGE TYPE

Model	Max. Working pressure	Volume Gal / Liter	Effective Gas Volume (Liter)	Weight (kg)	Dimension (mm)				
	Bar/psi				Dmax	A max	B	C	ØF
FLN-50-25A-S	50 / 725	25 / 100	93	155	577	852	192	100	SAE 50A 6000psi
FLN-50-40A-S	50 / 725	40 / 150	139	180	577	1055	192	100	SAE 50A 6000psi
FLN-50-50A-S	50 / 725	50 / 200	207	218	577	1354	192	100	SAE 50A 6000psi
FLN-50-80A-S	50 / 725	80 / 300	293	263	577	1730	192	100	SAE 50A 6000psi
FLN-50-100A-S	50 / 725	100 / 375	379	310	577	2111	192	100	SAE 50A 6000psi
FLN-50-125A-S	50 / 725	125 / 475	473	360	577	2525	192	100	SAE 50A 6000psi
FLN-50-140A-S	50 / 725	140 / 530	532	390	577	2784	192	100	SAE 50A 6000psi
FLN-50-150A-S	50 / 725	150 / 575	565	410	577	2933	192	100	SAE 50A 6000psi

MASH TYPE

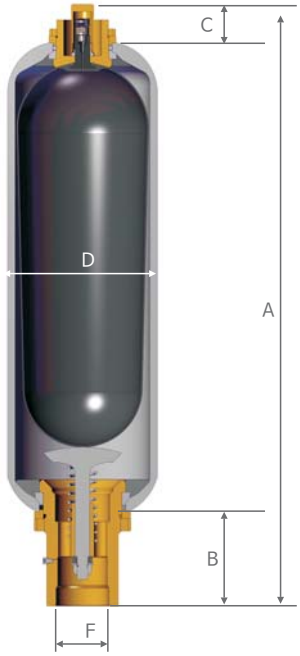
Model	Max. Working pressure	Volume Gal / Liter	Effective Gas Volume (Liter)	Weight (kg)	Dimension (mm)				
	Bar/psi				Dmax	A max	B	C	ØF
FLN-50-25A-M	50 / 725	25 / 100	93	165	577	805	192	100	M205x3
FLN-50-40A-M	50 / 725	40 / 150	139	190	577	1008	192	100	M205x3
FLN-50-50A-M	50 / 725	50 / 200	207	228	577	1307	192	100	M205x3
FLN-50-80A-M	50 / 725	80 / 300	293	273	577	1683	192	100	M205x3
FLN-50-100A-M	50 / 725	100 / 375	379	320	577	2064	192	100	M205x3
FLN-50-125A-M	50 / 725	125 / 475	473	370	577	2478	192	100	M205x3
FLN-50-140A-M	50 / 725	140 / 530	532	400	577	2737	192	100	M205x3
FLN-50-150A-M	50 / 725	150 / 575	565	420	577	2886	192	100	M205x3

[Note]

① Tolerance of "A" is ±10mm.
② Please refer to page 42~44 for bushing and flange.

7. Specification of Bladder Type Accumulator

8 FH-Series(High Flow Type)



Basic Information

- Max. Working pressure : 207bar(3,000psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : ASME Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

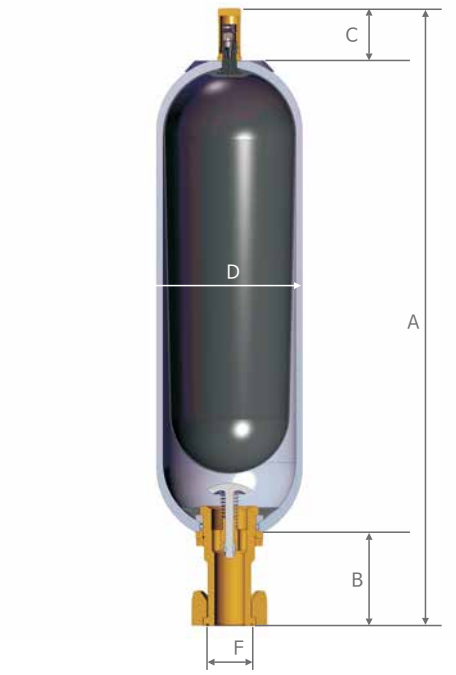
- Please refer to page 18 for more information of N_2 gas charging and control vale.
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +135℃)

Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)				
	Bar/psi				Dmax	A max	B	C	ØF
FHN-207-2.5A	207/3000	2.5 / 10	4800	36	228	596	140	62	M105x2
FHN-207-5A	207/3000	5 / 20	4800	56	228	901	140	62	M105x2
FHN-207-10A	207/3000	10 / 32	4800	94	228	1428	140	62	M105x2
FHN-207-11A	207/3000	11 / 42	4800	105	228	1577	140	62	M105x2
FHN-207-15A	207/3000	15 / 57	4800	138	228	2031	140	62	M105x2

[Note]

① Tolerance of "A" is ±10mm.
② Please refer to page 42~44 for bushing and flange.

9 FF-Series(SAE Flange Type)



Basic Information

- Max. Working pressure : 330bar(4,800psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : CE(AD2000) Certificated
- Material
  - Shell : Carbon Steel/34CrMo4
  - Fluid port : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Please refer to page 18 for more information of N_2 gas charging and control vale.
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +135℃)

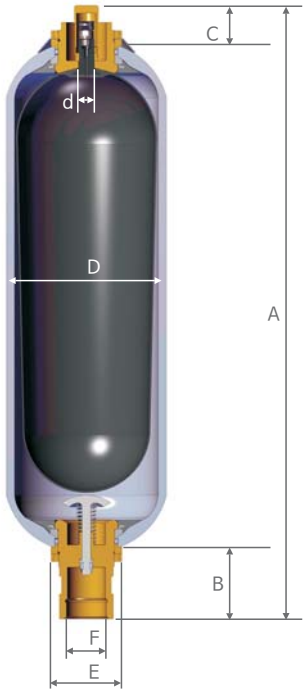
Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)				
	Bar/psi				Dmax	A max	B	C	ØF
FFN-330-2.5A	330/4800	2.5 / 10	1,800	40	219	625	143	79	SAE 50A 6000psi
FFN-330-3A	330/4800	3 / 12	1,800	49	219	725	143	79	SAE 50A 6000psi
FFN-330-5A	330/4800	5 / 20	1,800	59	219	935	143	79	SAE 50A 6000psi
FFN-330-6.5A	330/4800	6.5 / 24.5	1,800	75	219	1070	143	79	SAE 50A 6000psi
FFN-330-10A	330/4800	10 / 32	1,800	93	219	1457	143	79	SAE 50A 6000psi
FFN-330-11A	330/4800	11 / 42	1,800	115	219	1597	143	79	SAE 50A 6000psi
FFN-330-14A	330/4800	14 / 50	1,800	125	219	1983	143	79	SAE 50A 6000psi
FFN-330-15A	330/4800	15 / 57	1,800	151	219	2067	143	79	SAE 50A 6000psi

[Note]

① Tolerance of "A" is ±10mm.
② Please refer to page 42~44 for bushing and flange.

7. Specification of Bladder Type Accumulator

10 FS-Series(Stainless Steel Type)



Basic Information

- Max. Working pressure : 100bar(1,500psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
    (Please refer to page 19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : ASME Certificated
- Material
  - Shell : Stainless Steel/SUS316L
  - Fluid port : Stainless Steel/SUS316
    (Please refer to page 18 for special order for the inside coating and model)

[Note]

- Please refer to page 18 for more information of N_2 gas charging and control vale.
- Please refer to page 19 for how to order for bladder repair kit.
  (Please contact FLOWFORCE in case the working temperature is beyond the temperature range of -20℃ ~ +135℃)

Model	Max. Working pressure	Volume Gal / Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)						
	Bar/psi				Dmax	A max	B	C	Ød	ØE	ØF
FSN-100-2.5A	100/1500	2.5 / 10	900	39	229	562	103	62	89	101	G2"
FSN-100-5A	100/1500	5 / 20	900	61	229	873	103	62	89	101	G2"
FSN-100-10A	100/1500	10 / 32	900	99	229	1410	103	62	89	101	G2"
FSN-100-11A	100/1500	11 / 42	900	108	229	1540	103	62	89	101	G2"
FSN-100-15A	100/1500	15 / 57	900	140	229	1994	103	62	89	101	G2"

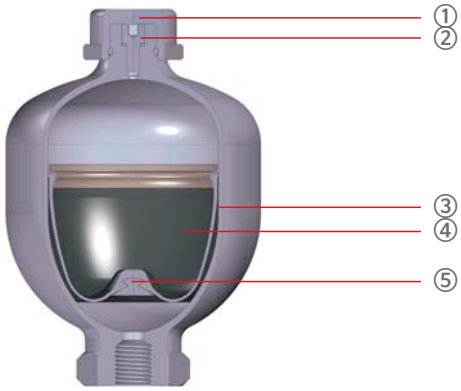
[Note]

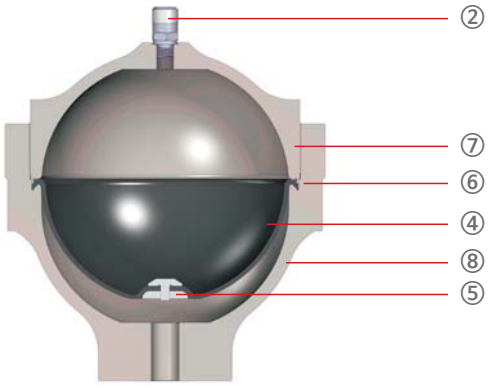
① Tolerance of "A" is ±10mm.
② Please refer to page 42~44 for bushing and flange.

8. Specification of Diaphragm/Membrane Accumulator

1 Basic information

Type/Series	FLM	FLMS
Max. Working pressure	250bar	400bar
Volume	0.07~3.5ℓ	0.2ℓ, 2.5ℓ, 4ℓ, 10ℓ
Material	Steel, Special Material	
Fluids	HFC, HLP, HFD	
Working temperature	-40℃ ~ +135℃	
Max. Flow rate	750, 1250ℓ/min	
Installation	Vertical / Horizontal / Opposite angle	
Shell	· Carbon Steel · Stainless Steel	
Oil / Gas Valve	· Carbon Steel · Stainless Steel	
Fluid port size	· PF(Standard) · Flange(SAE) · Special Connections available	
Bladder material	· NBR · Butyl · EPDM · Viton · ECO Bladder	
Certification	· PED 97/23 EC · CRN · All Class	





No.	Part list	재질
1	Protection cap	PLASTIC
2	GAS VALVE	STEEL
3	Body	STEEL/SCM
4	Diaphragm	NBR(Standard)
5	Button	PLA / AL
6	Back-up Ring	TEFLON
7	Upper Shell	SCM
8	Lower Shell	SCM

8. Specification of Diaphragm/Membrane Accumulator

2 Ordering Code for Diaphragm/Membrane Type Accumulator

①	②	③	④	⑤	⑥	⑦	⑧	⑨
FLM	- 1.5	- N	- 200	- C	- F	- S	- 50	- 01

① Type (Series)

FLM	용접형 Diaphragm Type
FLMS	나사형 Diaphragm Type

*Refer to page 30~32.

② Volume (Liter)

0.07	0.07Liter
0.16	0.16Liter
0.2	0.2Liter
0.32	0.32Liter
0.5	0.5Liter
0.6	0.6Liter
0.75	0.75Liter
1	1.0Liter
1.4	1.4Liter
2	2.0Liter
2.5	2.5Liter
2.8	2.8Liter
3.5	3.5Liter
4	4.0Liter
10	10Liter

③ Diaphragm Material

Blank	NBR
C	ECO
V	Viton
B	Butyl

*Refer to page 29.

④ Max. Working Pressure

160	160bar
210	210bar
250	250bar
330	330bar
350	350bar
400	400bar

⑤ Shell Material

C	Carbon Steel
S	Stainless Steel

⑥ Oil Connection Type

F	Female Type
M	Male Type

* Except, FLMS Accumulator

*Refer to page 32.

⑦ Charging Type

Blank	Welded type-Standard
S	Set Pressure type

* Except, FLMS Accumulator

⑧ Charging pressure

50	Charging at 50bar

* Charging pressure is based on the ambient temperature at 20℃

⑨ Class/Certification

Blank	None
01	CE(97/23/EC)
02	ASME
03	ABS
04	DNV
05	GL
06	LR
07	BV
08	NK
09	RINA
10	SELO
11	Other

* Please cotact FLOWFORCE for the special material of diaphragm.

3 How to order for Diaphragm Repair Kit

***Diaphragm Repair Kit is only for FLMS series.**

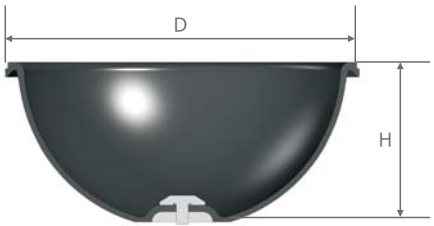
1) Select the model
: FLMS 4-400-100

2) Explanation of above selected model

- Type : FLMS (Thread Type)
- Volume : 4Liter
- Membrane Material : Blank (NBR)
- Max. Working Pressure : 400bar
- Parts for Kit : 100 (Diaphragm Kit)

3) Part list for Membrane Kit

Acc. Side	Gas valve	Body/Shell	Fluid Port Parts
Kit Component List	_	· Diaphragm · Back-up Ring	_



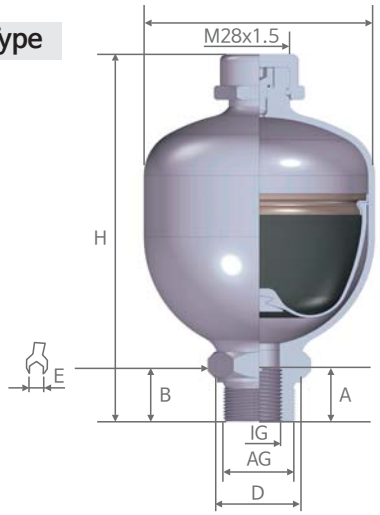
Membrane Volume (Liter)	Dimension	
	H (mm)	D (mm)
0.2	53	65
2.5	82	177
4	94	209
10	130	284

Membrane Material	Fluid	Working Temperature
NBR	Petroleum HYD Oil/Water	-10℃ ~ +85℃
Hydrin (ECO)		-30℃ ~ +110℃
Butyl	Phophate Ester	-40℃ ~ +120℃
Viton (FKM)	Phophate Ester Baesd Oil	-20℃ ~ +135℃

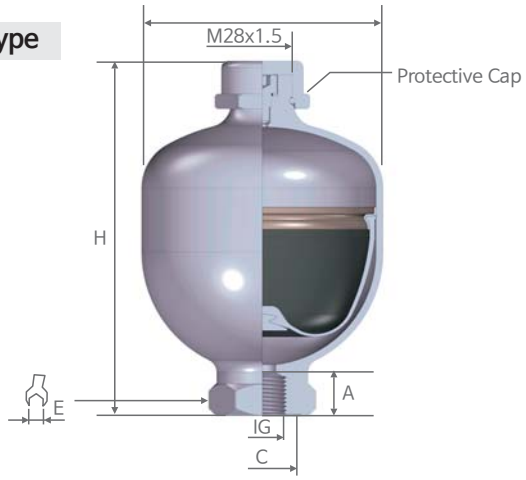
8. Specification of Diaphragm/Membrane Accumulator

4 FLM-Series (Standard Type)

Male Type



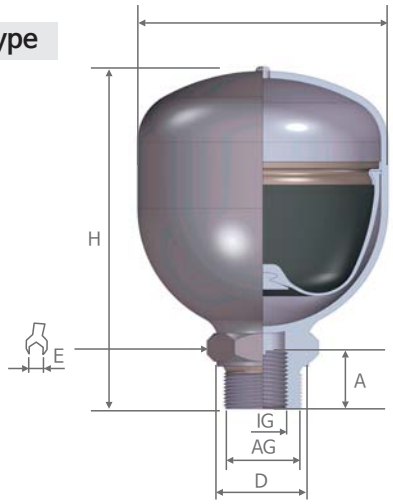
Female Type



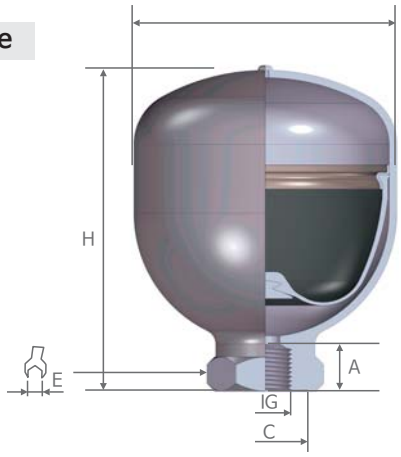
Model	Volume (ℓ)	Max. Working Pressure	Ratio (P2:P1)	A	B	C	D	E	Ø	H	Inner Thread IG	External Thread AG	Fluid Type
FLM 0.07-250-F	0.07	250	8:1	14	-	29	-	32	64	118	G1/2	-	Female
FLM 0.16-250-F	0.16	250	6:1	14	-	29	-	32	75	126	G1/2	-	Female
FLM 0.32-210-F	0.32	210	8:1	14	-	29	-	32	92	141	G1/2	-	Female
FLM 0.5-210-F	0.5	210	8:1	17	-	34	-	41	107	159	G1/2	-	Female
FLM 0.5-210-M	0.5	210	8:1	24	18	-	39	41	107	170	G1/2	M33X1.5	Male
FLM 0.75-210-F	0.75	210	8:1	17	-	34	-	41	122	173	G1/2	-	Female
FLM 0.75-210-M	0.75	210	8:1	24	18	-	39	41	122	184	G1/2	M33X1.5	Male
FLM 0.75-350-F	0.75	350	8:1	17	-	34	-	41	129	180	G1/2	-	Female
FLM 0.75-350-M	0.75	350	8:1	24	18	-	39	41	129	191	G1/2	M33X1.5	Male
FLM 1-210-F	1	210	8:1	17	-	34	-	41	136	187	G1/2	-	Female
FLM 1-210-M	1	210	8:1	24	18	-	39	41	136	198	G1/2	M33X1.5	Male
FLM 1.4-140-F	1.4	140	8:1	17	-	34	-	41	147	191	G1/2	-	Female
FLM 1.4-250-F	1.4	250	8:1	17	-	34	-	41	152	202	G1/2	-	Female
FLM 1.4-250-M	1.4	250	8:1	24	18	-	39	41	152	213	G1/2	M33X1.5	Male
FLM 1.4-350-F	1.4	350	8:1	17	-	34	-	41	156	201	G1/2	-	Female
FLM 1.4-350-M	1.4	350	8:1	24	18	-	39	41	156	212	G1/2	M33X1.5	Male
FLM 2.0-250-F	2	250	6:1	17	-	34	-	41	156	255	G1/2	-	Female
FLM 2.0-350-F	2	350	6:1	17	-	34	-	41	156	255	G3/4	-	Female
FLM 2.8-250-F	2.8	250	6:1	16	-	33	-	41	169	270	G3/4	-	Female
FLM 3.5-250-F	3.5	250	4:1	16	20	34	49	50	169	304	G3/4	-	Female

4 FLM-Series (Set-Pressure Type)

Male Type



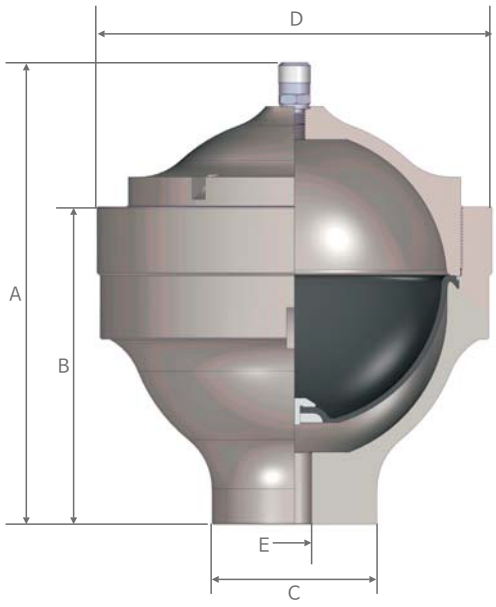
Female Type

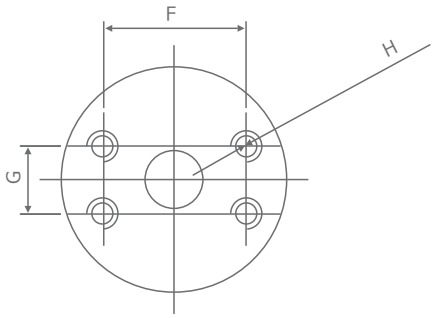


Model	Volume (ℓ)	Max. Working Pressure	Ratio (P2:P0)	Pressure Difference	A	B	C	D	E	ø	H	Inner Thread IG	External Thread AG	Fluid Type
FLM 0.075-250-F-S	0.075	250	8:1	210	14	-	29	-	32	64	91	G1/2	-	Female
FLM 0.16-250-F-S	0.16	250	6:1	180	14	-	29	-	32	75	99.5	G1/2	-	Female
FLM 0.16-250-M-S	0.16	250	6:1	180	-	12	-	22	27	75	104.5	G1/2	M16x1.5	Male
FLM 0.32-250-F-S	0.32	250	8:1	210	14	-	29	-	32	95	120	G1/2	-	Female
FLM 0.32-250-M-S	0.32	250	8:1	210	24	18	-	39	41	95	133	G1/2	-	Male
FLM 0.5-210-F-S	0.5	210	8:1	175	17	-	34	-	41	106.7	132	G1/2	-	Female
FLM 0.5-210-M-S	0.5	210	8:1	175	24	18	-	39	41	106.7	143	G1/2	M33x1.5	Male
FLM 0.5-250-F-S	0.5	250	8:1	175	17	-	34	-	41	106.7	132	G1/2	-	Female
FLM 0.5-250-M-S	0.5	250	8:1	175	24	18	-	39	41	106.7	143	G1/2	M33x1.5	Male
FLM 0.75-210-F-S	0.75	210	8:1	155	17	-	34	-	41	121.5	146	G1/2	-	Female
FLM 0.75-210-M-S	0.75	210	8:1	155	24	18	-	39	41	121.5	157	G1/2	M33x1.5	Male
FLM 0.75-250-F-S	0.75	250	8:1	155	17	-	34	-	41	123.6	149	G1/2	-	Female
FLM 0.75-250-M-S	0.75	250	8:1	155	24	18	-	39	41	123.6	160	G1/2	M33x1.5	Male
FLM 1-210-F-S	1	210	8:1	175	17	-	34	-	41	136.2	160	G1/2	-	Female
FLM 1-210-M-S	1	210	8:1	175	24	18	-	39	41	136.2	171	G1/2	M33x1.5	Male
FLM 1.0-350-F-S	1	350	4:1	-	17	-	34	-	41	129	205	G1/2	-	Female
FLM 1.0-350-M-S	1	350	4:1	-	24	18	-	39	41	129	217	G1/2	M33X1.5	Male
FLM 1.4-140-F-S	1	140	8:1	-	17	-	34	-	41	147	198	G1/2	-	Female
FLM 1.4-140-M-S	1	140	8:1	-	24	18	-	39	41	147	209	G1/2	M33X1.5	Male
FLM 1.4-210-F-S	1	210	8:1	-	17	-	34	-	41	147	198	G1/2	-	Female
FLM 1.4-210-M-S	1	210	8:1	-	24	18	-	39	41	147	209	G1/2	M33X1.5	Male

8. Specification of Diaphragm/Membrane Accumulator

5 FLMS-Series (Thread type)





Basic Information

- Max. Working pressure : 400bar (5,800psi)
- Working temperature (Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃ (-4℉ ~ +185℉)
    (Please refer to page #19 for other types of fluids and working temperature based on bladder material)
- Shell Design Code : Most of classification certifications are available
- Material
  - Shell : Carbon Steel/SCM440
    (Please refer to page 18 for special order for the inside coating and model)

[*Note*]

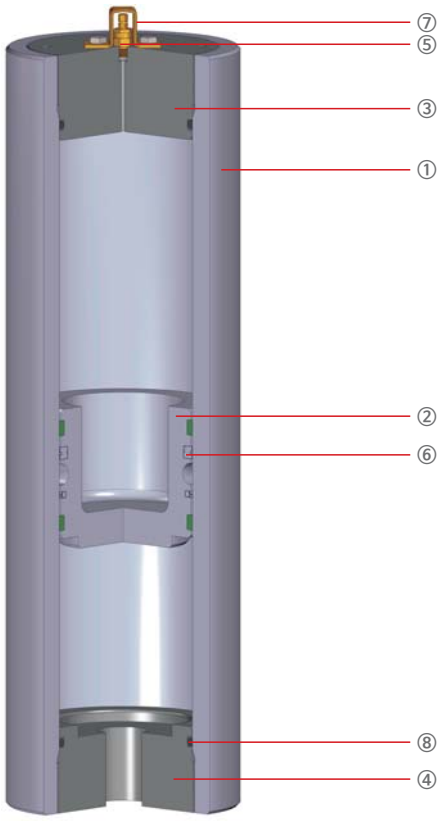
- Membrane accumulator (thread type) consists of upper and bottom shells that the diaphragm can replace.
- Special thread used for high temperature and pressure.

Model	Max. Working pressure	Gas volume Liter	Max. Flow rate (ℓ/min)	Weight (kg)	Dimension (mm)							
	Bar/psi				A max	B	C	D	E	F	G	H
FLMS-0.2-400	400/5800	0.2	-	3.7	175	116	56	84.5	12	18.2	40.5	M8x1.25
FLMS-2.5-400	400/5800	2.5	-	14	249	161	50	213.5	M33x2	-	-	-
FLMS-4.0-400	400/5800	4.0	750	22	302	202	105	251	22	31.7	66.7	M14x2
FLMS-10-400	400/5800	10	1250	53	390	268	105	339	28	31.7	66.7	M14x2

9. Specification of Piston Accumulator

1 Basic Information

Type / Series	FP
Max. Working pressure	375bar
Volume	1~350ℓ
Material	Steel, Stainless Steel, Special material
Fluids	HFC, HLP, HFD
Working temperature	-40℃ ~ +150℃
Installation	Vertical / Horizontal
Cylinder(Shell)	· Carbon Steel · Stainless Steel · Nickel Coating · Other coatings are available
Oil / Gas Valve	· Carbon Steel · Stainless Steel
Fluid port	· PF(Standard) · Flange(SAE) · Special Connections are available.
Seal material	· NBR · Butyl · EPDM · Viton(FKM)
Certification	· PED 97/23 EC · ASME+CRN · SELO · All Class



※ Piston Speed = Max. up to 4.0m/sec (Standard : 2.0m/sec)

Products for improving customer value

- Application of specialized FP-Series Pistion Accumulator :
  Optimize various fields such as agriculture, construction and other general industrial machinery.
- Dutability : Warranty long lifetime service
- Compact design
- Variety of materials : Selecting optimized materials according to the working temperature and fluid.
- Connection specification : A variety of conneections are available.
- Repair : Easy to assemble & disassemble.
- Optimal performance and durability test : Provide Fully pre-qualified products.
- Provide a high level of engineering service.

No.	Parts	Material
1	CYLINDER	Carbon (or stainless steel)
2	PISTON	AL
3	GAS END CAP	SCM
4	OIL END CAP	SCM
5	GAS VALVE	SUS
6	PISTON WITH SEAL	PTFE
7	CAP	AL
8	O-RING	NBR

9. Specification of Piston Accumulator

2 Ordering Code for Piston Accumulator

1	2	3	4	5	6	7	8	9	10	11	12
FP	- 220	- 001	- 100	- A	- N	- C	- A7	- A5	- A	- 01	- HP

1 Type (Series)

FP	Piston Type

*CE/ASME Regulation
*Refer to page 35~38.

2 Max. Working Perssure

220	220bar
350	350bar
375	375bar

3 Volume(Liter)

1	1Liter
,	
,	
350	350Liter

4 O.D of Tube

70	70
80	80
100	100
115	115
125	125
170	170
180	180
207	207
215	215
217	217
220	220
228	228
230	230
240	240
245	245
290	290
292	292
310	310
318	318
345	345
350	350
360	360
370	370

5 Gas Valve Size in charging

A	1/2"-20UNF male with 5/16-32UNF
B	1/2"-20UNF male with G1/4 SUS

6 Piston Seal Kit

N	Standard Seal NBR/PTFE
S	NBR/Special material
V	Viton Material
B	Butyl Material

7 Tube Material

C	Carbon Steel(Standard)
S	Stainless Steel

8 Oil Port Size

Refer to page 36

9 Gas Port Size

Refer to page 36

10 Safety Control(Gas)

Blank	None
A	Burst Disc (275bar/80℃)
B	Burst Disc (285bar/80℃)
C	Burst Disc (230bar/80℃)
D	Burst Disc (250bar/80℃)
E	Burst Disc (300bar/80℃)
F	Without Burst Disc. Plugged connection

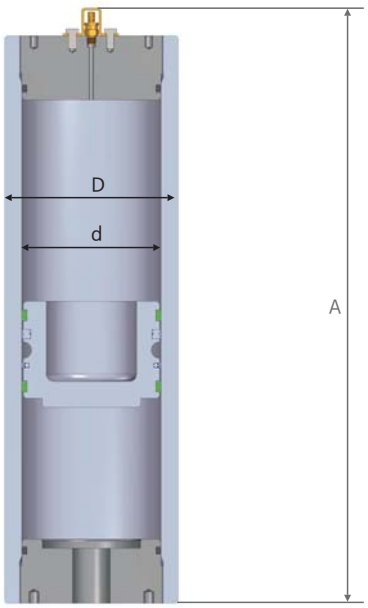
11 Class/Certification

Blank	None
01	CE (97/23/EC)
02	ASME
03	ABS
04	DNV
05	GL
06	LR
07	BV
08	NK
09	RINA
10	SELO
11	Other

12 HP

Blank	Standard Type(3.0m/s)
HP	4.0m/s

3 FP-Series(CE Certificated)



Basic Information

- Max. Working pressure : 200bar(3,200psi), 375bar(5,400psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
  - Piston speed: 3.0m/sec(standard)
- Cylinder Design Code : CE Approved
- Material
  - Cylinder : Carbon Steel/(Standard)
    Stainless Steel/SUS316L (Option)
  - Piston : Aluminum
  - Seal : PTFE (Polytetrafluoroethylene. Teflon)
    (Please contact FLOWFORCE for the special sealing)

[Note]

- Please contact FLOWFORCE for any other application.

Model	Pressure (bar)	Pressure (psi)	Volume (ℓ)	O.D ØD (mm)	I.D Ød (mm)	Length A (mm)	Weight (kg)	Oil Port	Gas Port
FP-220-001-070-A-A-01	220	3200	1	70	60	475	7	G1/2	1/4
FP-375-001-080-A-A-01	375	5400	1	80	60	505	12	G1/2	1/4
FP-220-002-070-A-A-01	220	3200	2	70	60	830	10	G1/2	1/4
FP-375-002-080-A-A-01	375	5400	2	80	60	860	18	G1/2	1/4
FP-220-006-100-A-A-01	220	3200	6	100	80	1325	33	G1/2	1/4
FP-375-006-100-A-A-01	375	5400	6	100	80	1345	36	G1/2	1/4
FP-220-010-115-A-A-01	220	3200	10	115	100	1460	46	G3/4	1/4
FP-375-010-125-A-A-01	375	5400	10	125	100	1460	58	G3/4	1/4
FP-220-020-170-A-A-01	220	3200	20	170	150	1325	70	G1	1/4
FP-350-020-180-A-A-01	350	5100	20	180	150	1365	108	G1	1/4
FP-220-030-170-A-A-01	220	3200	30	170	150	1890	93	G1	1/4
FP-350-030-180-A-A-01	350	5100	30	180	150	1930	142	G1	1/4

9. Specification of Piston Accumulator

3 FP-Series (CE Certificated)

Model	Pressure (bar)	Pressure (psi)	Volume (ℓ)	O.D ØD (mm)	I.D Ød (mm)	Length A (mm)	Weight (kg)	Oil Port	Gas Port
FP-220-040-215-A-A-01	220	3200	40	215	180	1822	186	G1	1/4
FP-350-040-220-A-A-01	350	5100	40	220	180	1822	177	G1	1/4
FP-220-050-215-A-A-01	220	3200	50	215	180	2215	220	G1	1/4
FP-350-050-220-A-A-01	350	5100	50	220	180	2215	249	G1	1/4
FP-220-060-215-A-A-01	220	3200	60	215	180	2608	237	G1"1/2	1/4
FP-350-060-220-A-A-01	350	5100	60	220	180	2608	288	G1"1/2	1/4
FP-220-080-228-A-A-01	220	3200	80	228	200	2807	249	G1"1/2	1/4
FP-350-080-245-A-A-01	350	5100	80	245	200	2781	466	G1"1/2	1/4
FP-220-100-228-A-A-01	220	3200	100	228	200	3444	286	G1"1/2	1/4
FP-350-100-245-A-A-01	350	5100	100	245	200	3418	565	G1"1/2	1/4
FP-220-150-292-A-A-01	220	3200	150	292	250	3361	548	G1"1/2	1/4
FP-350-150-318-A-A-01	350	5100	150	318	250	3361	871	G1"1/2	1/4
FP-220-350-345-A-A-01	220	3200	350	345	310	3215	880	G1"1/2	1/4
FP-350-350-350-A-A-01	350	5100	350	350	310	3305	1040	G1"1/2	1/4

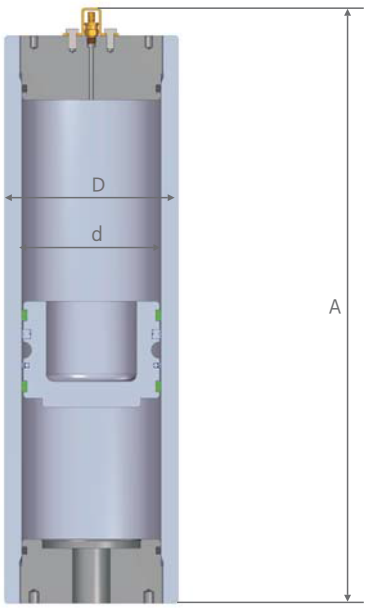
* Oil Port / Gas Port Size

	Code	1	2	3	4	5	6	7	8	9	10	11
Thread to ISO 228-1 (G)	A	G1/8	G1/4	G3/8	G1/2	G5/8	G3/4	G7/8	G1	G1"1/4	G1"½	G2
SAE thread ISO 6162	B	1/2	3/4	1	1"1/4	1"1/2	2	2"1/2	3			
SAE connection (UN)	C	1/2-20	9/16-18	3/4-16	7/8-14	1"1/16-12	1"5/16-12	1'5/8-12	1"7/8-12	2"1/2-12		
Thread to ISO 6149-1 (M)	D	M10x1	M12x1.5	M14x1.5	M18x1.5	M22x1.5	M27x2	M33x2	M42x2	M48x2		
Combined connection	E	SAE2/G1"1/2		G1/G1/2	G1/2/G1/2	G1/2/G1/4						
NPT thread to ANSI B1.20.1	F	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1	1"1/4	1"1/2	2

Model	Pressure (bar)	Pressure (psi)	Volume (ℓ)	Outside-Ø ØD (mm)	Piston-Ø Ød (mm)	Length A (mm)	Weight (kg)	Oil Side	Gas Side
FP-350-0002-080-A-A-01	350	5100	0.2	80	60	220	6	-	M28x1.5
FP-350-0005-080-A-A-01	350	5100	0.5	80	60	325	7.7	-	M28x1.5
FP-350-0005-100-A-A-01	350	5100	0.5	100	80	250	10.3	-	M28x1.5
FP-350-0007-080-A-A-01	350	5100	0.75	80	60	415	9.3	-	M28x1.5
FP-350-001-080-A-A-01	350	5100	1	80	60	505	10.7	-	M28x1.5
FP-350-001-100-A-A-01	350	5100	1	100	80	350	12.3	-	M28x1.5
FP-350-001-125-A-A-01	350	5100	1	125	100	295	18.3	-	M28x1.5
FP-350-0015-100-A-A-01	350	5100	1.5	100	80	450	14.5	-	M28x1.5
FP-350-0015-125-A-A-01	350	5100	1.5	125	100	360	20.5	-	M28x1.5
FP-350-002-100-A-A-01	350	5100	2	100	80	550	16.8	-	M28x1.5
FP-350-002-125-A-A-01	350	5100	2	125	100	425	23	-	M28x1.5
FP-350-002-155-A-A-01	350	5100	2	155	125	345	31.5	-	M28x1.5
FP-350-0025-125-A-A-01	350	5100	2.5	125	100	490	25.3	-	M28x1.5
FP-350-003-125-A-A-01	350	5100	3	125	100	555	27.5	-	M28x1.5
FP-350-004-155-A-A-01	350	5100	4	155	125	509	40.5	-	M28x1.5
FP-350-005-155-A-A-01	350	5100	5	155	125	590	44.5	-	M28x1.5
FP-350-006-185-A-A-01	350	5100	6	185	150	545	65.5	-	M28x1.5

※ Oil Side : G1/2, G3/4, G1, G1"1/2

3 FP-Series (ASME Certificated)



Basic Information

- Max. Working pressure : 200bar(3,200psi), 375bar(5,400psi)
- Working temperature(Petroleum-based hydraulic fluid)
  - Standard : Buna/Nitrile : -20℃ ~ +85℃(-4℉ ~ +185℉)
  - Piston speed: 3.0m/sec(standard)
- Cylinder Design Code : ASME Approved
- Material
  - Cylinder : Carbon Steel/(Standard)
    Stainless Steel/SUS316L (Option)
  - Piston : Aluminum
  - Seal : PTFE (Polytetrafluoroethylene. Teflon)
    (Please contact FLOWFORCE for the special sealing)

[*Note*]

Please contac **FLOWFORCE** for any other application.

Model	Pressure (bar)	Pressure (psi)	Volume (ℓ)	O.D ØD (mm)	I.D Ød (mm)	Length A (mm)	Weight (kg)	Oil Port	Gas Port
FP-220-010-207-A-A-02	220	3200	10	207	180	720	93	G3/4	1/4
FP-375-010-217-A-A-02	375	5400	10	217	180	755	121	G3/4	1/4
FP-220-020-207-A-A-02	220	3200	20	207	180	1115	119	G1	1/4
FP-375-020-217-A-A-02	375	5400	20	217	180	1145	157	G1	1/4
FP-220-030-207-A-A-02	220	3200	30	207	180	1510	144	G1	1/4
FP-375-030-217-A-A-02	375	5400	30	217	180	1540	193	G1	1/4
FP-220-040-207-A-A-02	220	3200	40	207	180	1900	169	G1	1/4
FP-375-040-217-A-A-02	375	5400	40	217	180	1930	228	G1	1/4

9. Specification of Piston Accumulator

3 FP-Series (ASME Certificated)

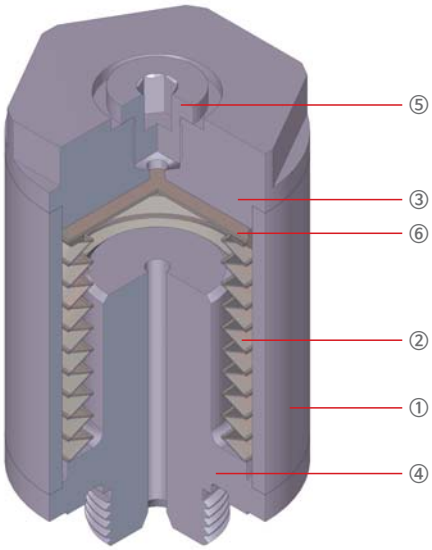
Model	Pressure (bar)	Pressure (psi)	Volume (ℓ)	O.D ØD (mm)	I.D Ød (mm)	Length A (mm)	Weight (kg)	Oil Port	Gas Port
FP-220-050-207-A-A-02	220	3200	50	207	180	2295	195	G1	1/4
FP-375-050-217-A-A-02	375	5400	50	217	180	2325	264	G1	1/4
FP-220-060-207-A-A-02	220	3200	60	207	180	2690	220	G1"½	1/4
FP-375-060-217-A-A-02	375	5400	60	217	180	2720	300	G1"1/2	1/4
FP-220-080-207-A-A-02	220	3200	80	207	180	3475	271	G1"1/2	1/4
FP-375-080-217-A-A-02	375	5400	80	217	180	3505	371	G1"1/2	1/4
FP-220-100-230-A-A-02	220	3200	100	230	200	3525	338	G1"1/2	1/4
FP-350-100-240-A-A-02	350	5100	100	240	200	3585	462	G1"1/2	1/4
FP-220-150-290-A-A-02	220	3200	150	290	250	3475	618	G1"1/2	1/4
FP-350-150-310-A-A-02	350	5100	150	310	250	3525	918	G1"1/2	1/4
FP-220-350-360-A-A-02	220	3200	350	360	310	5200	1306	G1"1/2	1/4
FP-350-350-370-A-A-02	350	5100	350	370	310	5290	1556	G1"1/2	1/4

10. Specification of Bellows Accumulator

1 Basic Information

Type / Series	FBL
Max. Working pressure	50bar
Volume	0.043ℓ
Material	Steel, Stainless Steel, Special material available
Fluids	HFC, HLP, HFD
Working temperature	−65℃ ~ +160℃
Installation	Vertical / Horizontal
Shell (Body)	· Carbon Steel · Stainless Steel
Oil / Gas Valve	· Carbon Steel · Stainless Steel
Fluid Port	· PF(Standard) · Flange(SAE) · Special Connections available
Seal material	· NBR · EPDM · Butyl · Viton (FKM)
Certification	· PED 97/23 EC · SELO · All Class

* Customized orders are available.



No.	Part list	Material
1	Shell	Stainless Steel
2	Bellows(Spring)	Stainless Steel
3	Filling Flange	Stainless Steel
4	Fluid Port Flange	Stainless Steel
5	Gas Cap	Stainless Steel
6	Seal	-

10. Specification of Bellows Accumulator

2 Ordering code for Bellows Accumulator

1	2	3	4	5	6	7	8
FBL	- 0.043	- A	- 1	- C	- M	- 1	- 01

1 Type (Series)

FBL	Metal Bellows Type

*Refer to page 41.

2 Volume(Liter)

0.043	0.043 Liter

(Other volumes are available upon request.)

3 Thread Type

A	Screw Type
B	Weld Type

4 Oil Port Size

1	M20X1.5
2	Others(_____)

5 Gas Valve Size in charging

C	1/4'BSP(Standard)
B	5/16"

6 Oil Port Size

C	Car1/4'BSP(Standard)
B	5/16"
M	M20x1.5

7 Seal Material

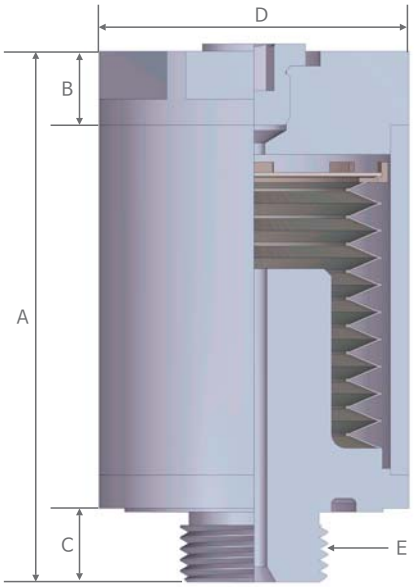
1	NBR
2	Low temperature NBR
3	Viton (FKM)

8 Class/Certification

Blank	NONE
01	CE(97/23/EC)
02	ASME
03	ABS
04	DNV
05	GL
06	LR
07	BV
08	NK
09	RINA
10	SELO

3 FBL-Series

This FBL Series is 100% custom-made product and please contact **FLOWFORCE** before placing the order.



Summary

Metal Bellows Element is specially designed to separate N_2 gas and fluid from the accumulator.

Basic Information

- Working pressure : 16bar(Standard)
  (Max. Working pressure up to 210bar as per customer request)
- Working temperature : -65℃ ~ +160℃(-85℉ ~ +320℉)
- Zero pressure loss for N_2 gas
- Maintenance - Free type
- Basically same function and feature with other types(Bladder, Piston, Diaphragm) of accumulator

Summary

- Energy accumulation / Thermal expansion compensation
- Pulse absorption
  (Vessel Diesel Engine, Mobile Suspension / Transmission, Wind mill, Aircraft, Chemical plant, etc)

Basic structure

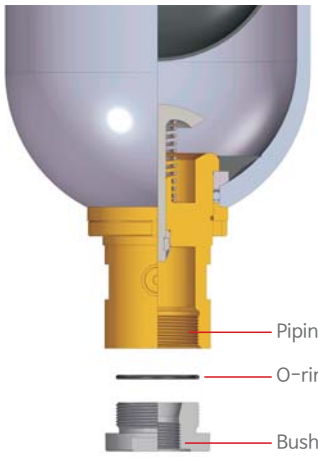
Pressure	Low pressure	High pressure
Type	Standard type(Formed)	Welded type(Bellow)
Feature	· Pulse absorption · Resistance to contamination	· Good to be used for energy accumulation and discharge a large volume
Feature		

Model	Max.Working Pressure	Gas volume cc / Liter	Weight (kg)	Dimension (mm)				
	bar/psi			Dmax	Amax	B	C	ØE
FBL-16-0.043	16 / 232	43 / 0.043	5	42	72	6.5	9.5	M20 X 1.5

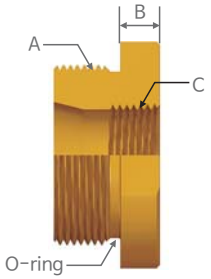
11. Bushing & Flange

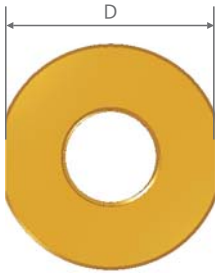
1 Bushing

Bushing

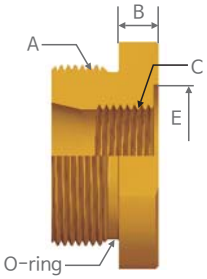


PT-Type



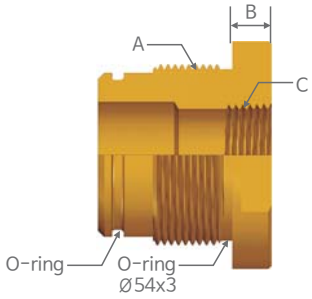


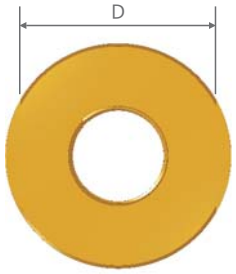
PF-Type



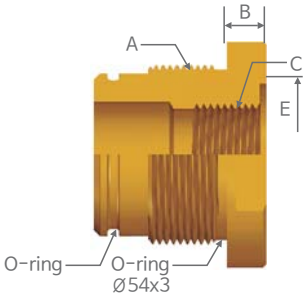
Code	Volume Category	O-Ring Size	Dimension (mm)				
			A	B	C	D	E
B01	2.5~6L (G1" 1/4)	36.2 X3.0	G1"1/4	15	PT1"	50	-
B02			G1"1/4	15	PT3/4	50	-
B03			G1"1/4	15	PT1/2	50	-
B04			G1"1/4	15	PT3/8	50	-
B05			G1"1/4	28	PF1"	50	44
B06			G1"1/4	15	PF3/4	50	42
B07			G1"1/4	15	PF1/2	50	34
B08			G1"1/4	15	PF3/8	50	28
B09	10~57L (G2")	54.0 X3.0	G2"	15	PT1"	70	-
B10			G2"	15	PT3/4	70	-
B11			G2"	15	PT1/2	70	-
B12			G2"	15	PT3/8	70	-
B13			G2"	15	PF1"	70	47
B14			G2"	15	PF3/4	70	42
B15			G2"	15	PF1/2	70	34
B16			G2"	15	PF3/8	70	28

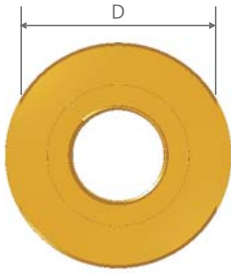
PT-Type



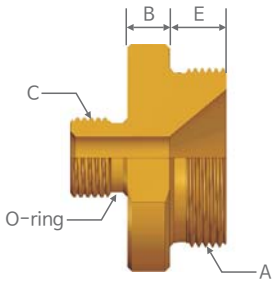


PF-Type





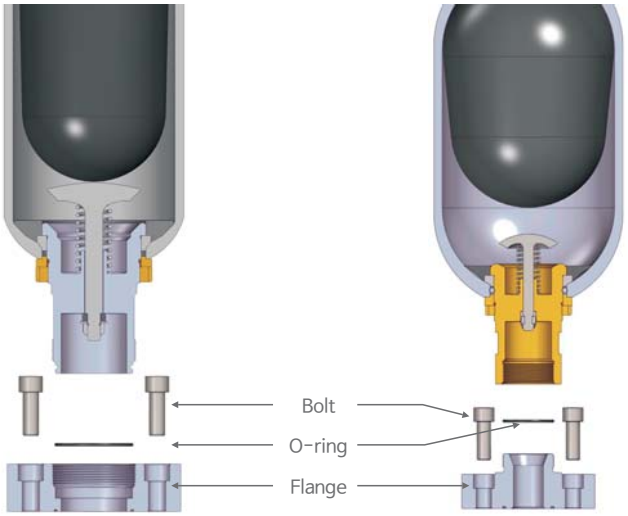
Code	Volume Category	O-Ring Size	Dimension (mm)				
			A	B	C	D	E
B17	10~57L (G2")	O-RING : 43.82X5.33 Back-up Ring : 45X54X0.85	G2"	13	PT1"	70	-
B18			G2"	13	PT3/4	70	-
B19			G2"	13	PT1/2	70	-
B20			G2"	13	PT3/8	70	-
B21			G2"	13	PF1"	70	47
B22			G2"	13	PF3/4	70	42
B23			G2"	13	PF1/2	70	34
B24			G2"	13	PF3/8	70	28



Code	Volume Category	O-Ring Size	Dimension (mm)				
			A	B	C	D	E
B25	2.5~6L	36.2 x3.0	G1"1/4	15	PF1/2"	52	20
B26	2.5~6L	36.2 x3.0	G1"1/4	15	PF3/4"	52	20
B27	10~57L	54.0 x3.0	G2"	15	PF3/4"	52	20
B28	10~57L	54.0 x3.0	G2"	15	PF1"1/4	52	20

11. Bushing & Flange

2 Flange



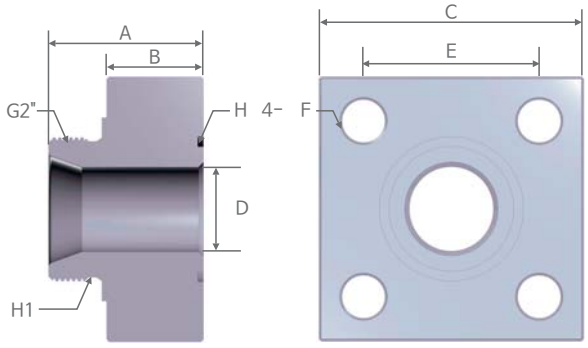


Fig 1

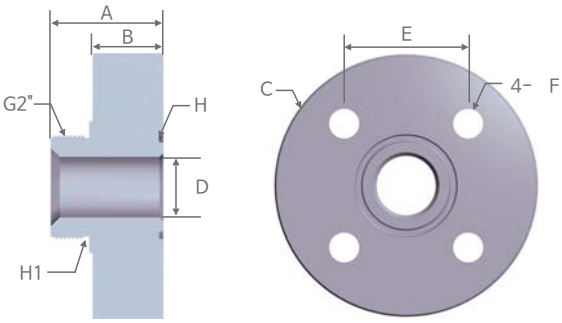


Fig 2

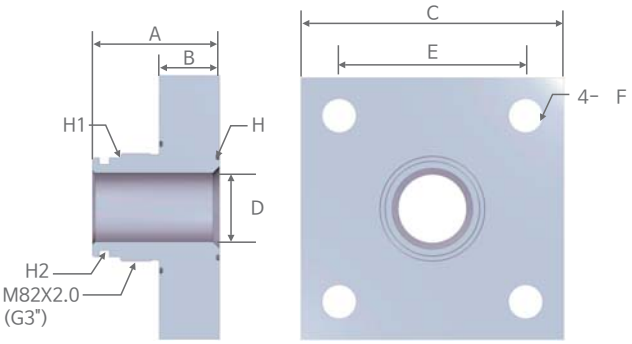


Fig 3

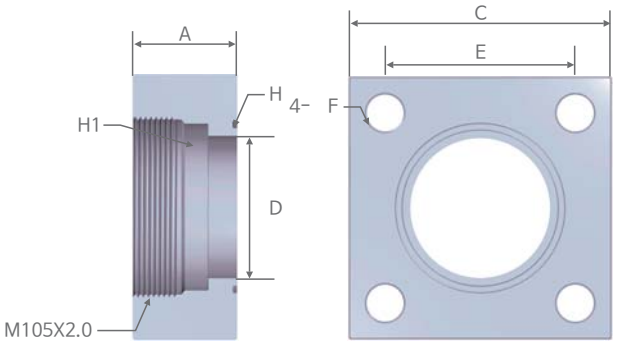
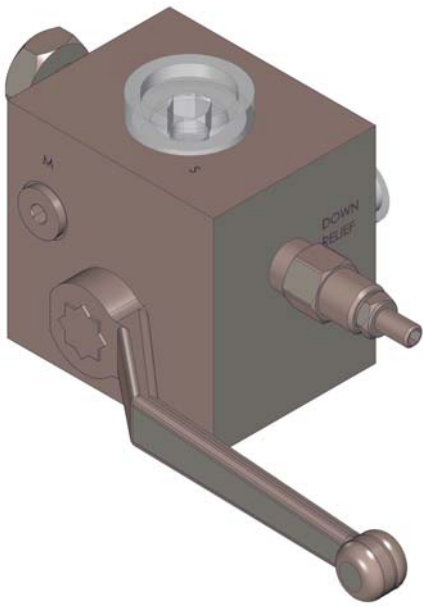


Fig 4

Code	Volume Category	Figure	Dimension (mm)						O-Ring Size			Thread size
			A	B	C	D	E	F	H	H1	H2	S
F01	4L~6L	Fig1	64	40	110	29	73	18	G55	G95		G1"1/4
F02	10~57L	Fig1	64	40	110	35	73	18	G55			G2"
F03		Fig2	64	40	155	35	73	18	G55			G2"
F04		Fig3	40	45	200	52	142	32	G75		P65	M82x3.0
F05		Fig4	50	-	155	82	112	22	G90		-	M105x2.0
F06	63~200L	Fig3	95	45	200	66	142	32	G75	G100	P70	G3"

12. Safety Block

1 FSV-Series



Basic Specification

- Working Pressure: 360bar(5,221psi)
- Temperature Range
  - Manual drain : -10℃ ~ +80℃
  - Electrical drain : -10℃ ~ +60℃
- Material
  - Body : Carbon Steel.
  - Sealing : NBR as standard(Viton as option)
- Electrical data
  DC : 24V
  AC : 110V or 220v, 50~60Hz

- Safety block comes with manual and electrical type.
- Please ensure to check the connecting size when assembling with accumulators.

2 Ordering Code for Safety Block

① FSV - ② 12 - ③ 01 - ④ L - ⑤ N

① Type (Series)	
FSV	Safety Block

*Refer to page 46.

② Model/Size	
12	G1/2"
20	G3/4"
32	G1"1/4

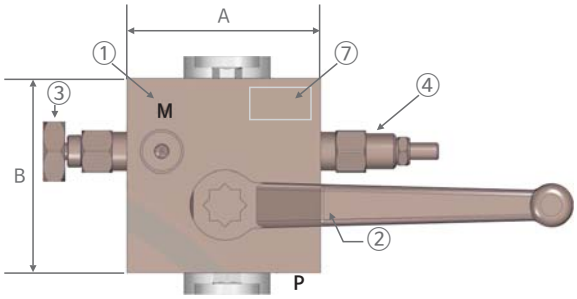
③ Relief Valve Type	
01	Manual
02	Manual & Electrical

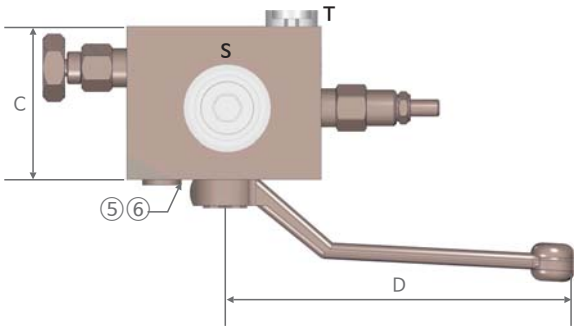
④ Seal Material	
L	Nitrile
V	Fluorocarbon

⑤ Voltage	
N	None
G	DC 24V
A	AC 110V
B	AC 220V

12. Safety Block

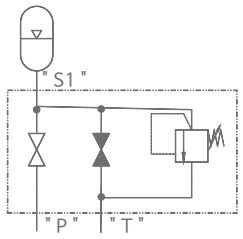
1 FSV-Series Safety Block



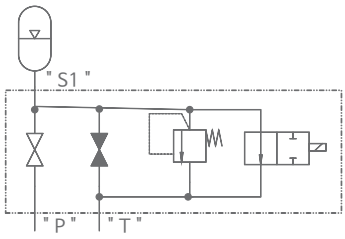


Part List

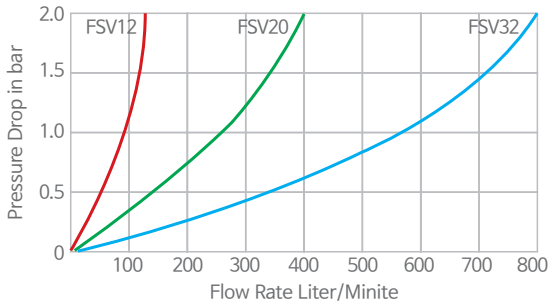
1	Safety Block Housing FSV Valve Assy Kit
2	Ball Valve Kit
3	Manual Pump Valve
4	Spring Relief Valve
5	Blanking Plug 1/4" BSP
6	Bonded Seal 1/4" BSP
7	Label



Type 1



Type 2



Pressure Drop / Flow Rate through Safety Block

Code	"S" port Accmulator	"P" port process	"T" port gauge	"M" port gauge	Dimension (mm)			
					A	B	C	D
FSV12	G1/2"	G1/2"	G1/4"	G1/4"	76	94	66	115
FSV20	G3/4"	G3/4"	G3/8"	G1/4"	89	89	70	160
FSV32	G1"1/4	G1"1/4	G3/8"	G1/4"	89	129	88	300

13. N_2 Gas Charging Kit 1 Universal Type

1 Ordering Code for N_2 Charging Kit

①		②		③		④		⑤		⑥		⑦
FCU	-	250	-	1	-	1	-	1	-	R	-	K

*FCU Charging kit is a universal type that covers most types of accumulators for N_2 gas charging.

① Type (Series)		② Pressure Gauge		③ Charging Adapter	
FCU	Charging Kit	25	25bar	1	G1/4
*Refer to page 48.		250	250bar	2	5/8-18UNF
		25/250	25/250bar	3	5/16-24UNF
				4	7/8-14UNF(Short)
				5	7/8-14UNF(Long)
				6	1+2+3+4+5
				7	1+2+3
				8	2+3

④ Hose		⑤ Charging Case		⑥ Regulator		⑦ N_2 Bottle Valve	
0	None	0	None	O	None	K	Korean Standard
1	2.8m, 200bar(Standard)	1	Case	R	Regulator		
2	2.8m, 400bar						

1-1 FCU consists of

FCU charging kit has a variety of adapters available to cover all the different connections of accumulators.

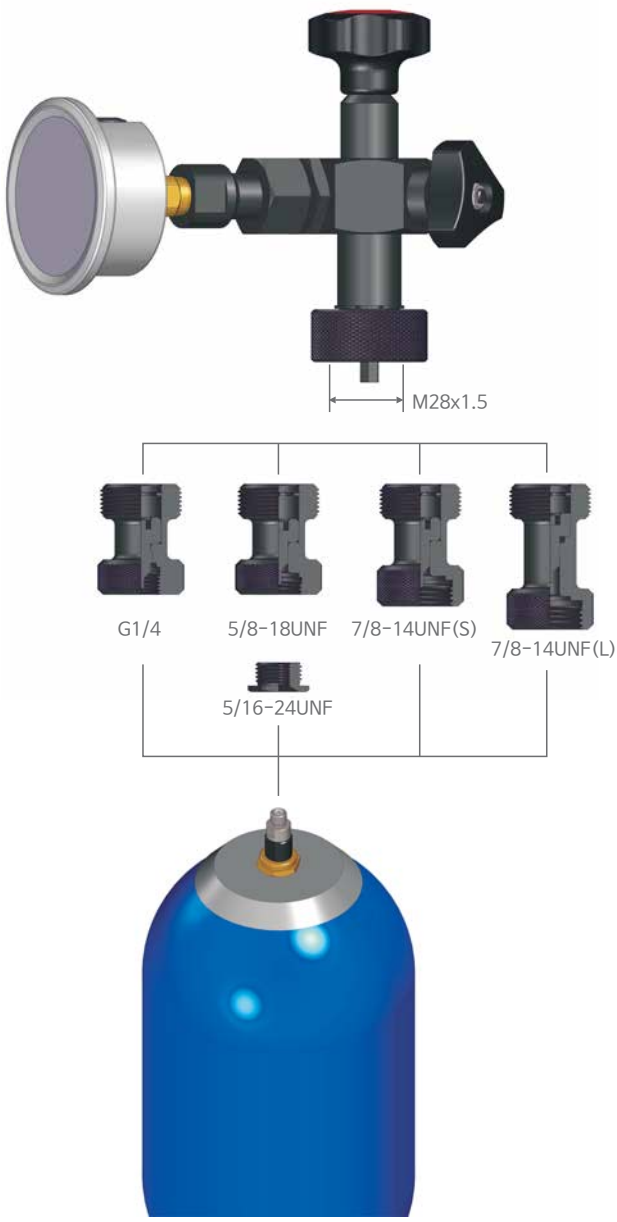
Charging Unit Body
Gas valve
Pressure gauge 25 bar
Pressure gauge 250 bar
High Pressure Hose(2.8M, 200bar)
Charging Adapter
Spare parts(sealing)
Regulator

※. Pressure Gauges and length of charging hose are available as per requirements.

13. N_2 Gas Charging Kit

1 Universal Type

2 Detailed outline drawing



Charging Adapter

Code	Size
2E114-101-00	G1/4
2E114-103-00	5/8-18UNF
2E114-104-00	7/8-14UNF(S)
2E114-105-00	7/8-14UNF(L)
2E114-106-00	5/16-24UNF

Size	Applicable brand
G1/4	FLOWFORCE, SGPT
7/8-14UNF	OLAER
5/8-18 UNF	EPE, NOK, OLAER
5/16-24 UNF	Nakamura, Greer, Bosch

Charging Hose(2.8m, 200bar)

Connecting to N_2 Bottle Valve

Code	Size
CH028	W22-14

13. N_2 Gas Charging Kit 2 Standard Type

1 Ordering Code for N_2 Charging Kit

①		②		③		④		⑤		⑥		⑦
BCG	-	250	-	1	-	1	-	1	-	R	-	K

*BCG Charging kit is only for the bladder type accumulators.

① Type (Series)		② Pressure Gauge		③ Charging Adapter Connection	
BCG	Charging Kit	25	25bar	1	5/8-18UNF
		250	250bar	2	7/8-14UNF(Short)
		25/250	25/250bar	3	5/16-24UNF
				4	1+2+3

④ Hose		⑤ Charging Case		⑥ Regulator		⑦ N_2 Bottle Valve	
0	None	0	None	O	None	K	Korean Standaed
1	2.8m, 200bar(Standard)	1	Including Charging Case	R	Regulator		
2	2.8m, 400bar						

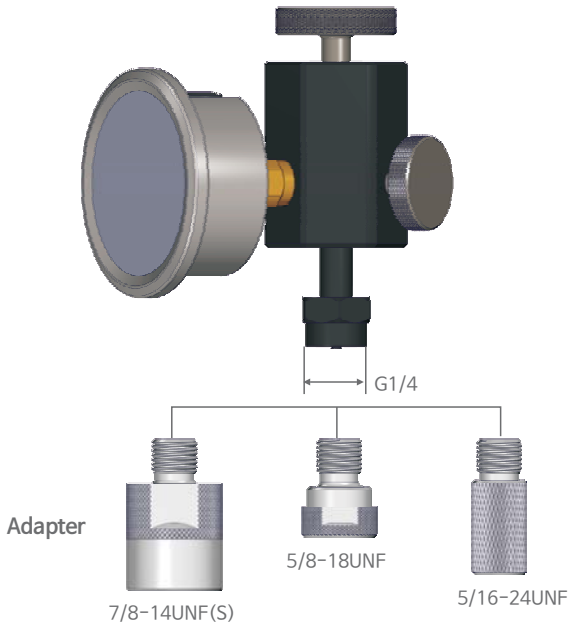
1-1 Main parts of BCG Charging kit

BCG charging kit has a variety of adapters available to cover all the different connections of accumulators.

- Charging Unit Body
- Gas valve
- Pressure gauge 25 bar
- Pressure gauge 250 bar
- High Pressure Hose(2.8M, 200bar)
- Charging Adapter
- Spare parts(sealing)
- Ragulator

13. N_2 Gas Charging Kit 2 Standard Type

2 Detailed outline drawing



Charging Adapter

Code	Size
1E114-103-00	5/8-18UNF
1E114-104-00	7/8-14UNF
1E114-106-00	5/16-24UNF

Size	Applicable Brand
7/8-14UNF	OLAER, Hyundai Olaer
5/8-18 UNF	EPE, NOK, OLAER, Hyundai olaer
5/16-24 UNF	Nakamura, Greer, Bosch, Hydac

Charging Hose(2.8m, 200bar)

Connecting to N_2 Bottle Valve

Code	Size
CH028	W22-14

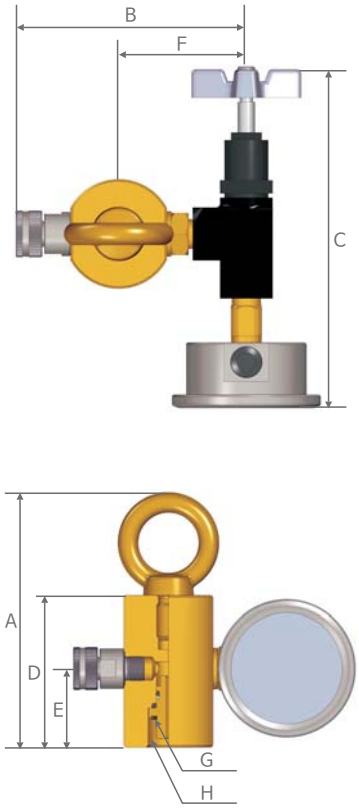
14. N_2 Gas Port Gauging & Control Valve

1 CPG (Charging & Permanent Gauge) Series

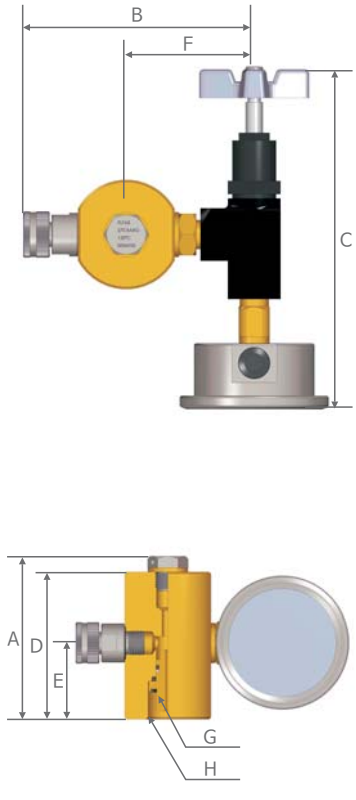
① CPG - ② I - ③ 250 - ④ D

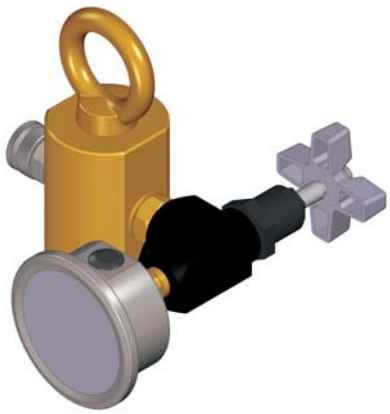
① Type (Series)	② Safety Valve	③ Pressure Gauge	④ Gauge Type
CPG	Bank Without Eyebolt	250 250bar (Standard)	D Horizontal Type (Standard)
	I With Eyebolt		A Vertical Type
	B Pressure Burst Disc		

CPGI-Type
(With Eyebolt)



CPGB-Type
(With Pressure Burst Disc)



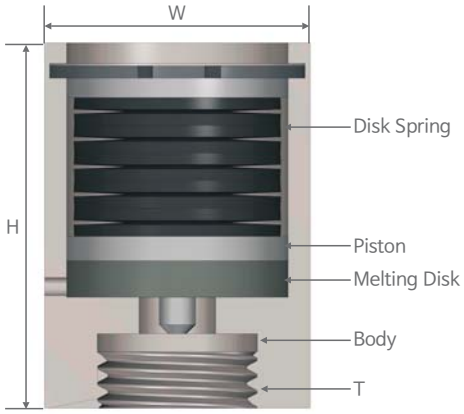


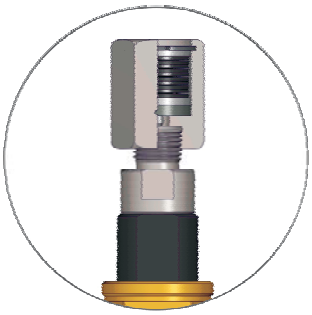
D-Type

Code	Model No	kg	Dimension (mm)							
			A	B	C	D	E	F	G	H
CPG01	CPG-250-D	1.82	75	109	148	75	39	60	1/2-20UNF	7/8-14UNF
CPG02	CPGI-250-D	1.94	126	109	148	75	39	60	1/2-20UNF	7/8-14UNF
CPG03	CPGB-250-D	1.84	83	109	148	75	39	60	1/2-20UNF	7/8-14UNF

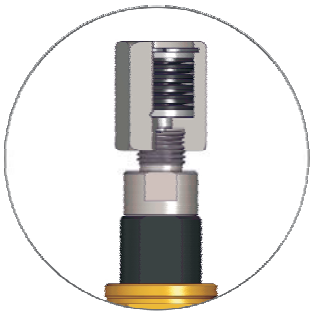
14. N_2 Gas Port Gauging & Control Valve

2 TR Cap (Fusible-plug Safety Valve)





Before

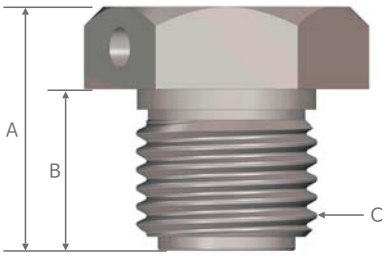


After
(Press the valve stem and released the seal)

Code	Working temperature	Dimension (mm)		
		W	H	T
TRC1-150	150℃	22	30	5/8-18UNF
TRC2-150	150℃	22	30	1/4 BSP

※ Please ensure the code when placing TR Cap separately.

3 Pressure Burst Disc

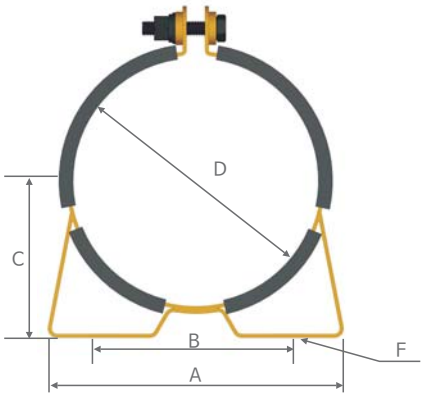


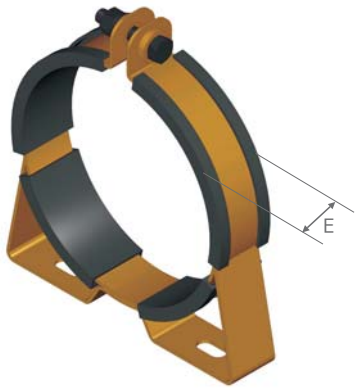
Code	Working temperature	Dimension (mm)		
		A	B	C
PBD-270	270bar/120℃	17.7	11.7	1/4 BSP

※ Pressure / Temperature : 270bar / 120℃
※ Please ensure the code when placing Pressure Burst Disc separately.

15. Clamp Band

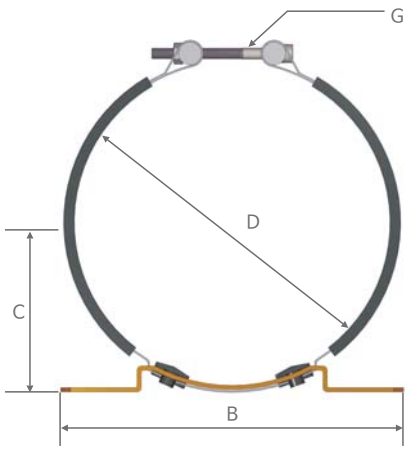
1 Diaphragm Type (Carbon Steel)

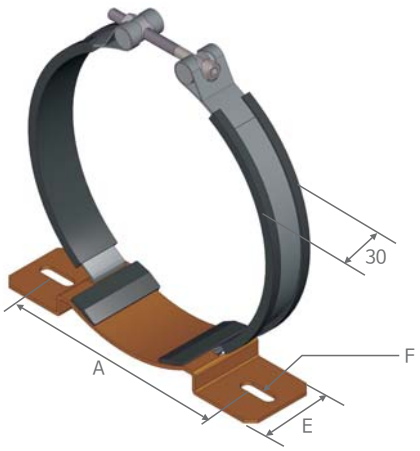




Code	Volume Category	Dimension (mm)					
		A	B	C	D	E	F
C091	0.32ℓ	88	140	54	91	30	9
C105	0.5ℓ	88	140	68	105	30	9
C120	0.75ℓ	88	140	76	120	30	9
C136	1.0ℓ	88	140	85	136	30	9
C155	1.4~2.0ℓ	137	190	87	155	30	9
C168	2.8~3.5ℓ	137	190	96	168	30	9
C179	2.8~3.5ℓ	137	190	100	179	30	9

2 Bladder Type (Stainless Steel)





Code	Volume Category	Dimension (mm)						
		A	B	C	D	E	F	G
A114	1~2.5ℓ	110	140	72	114	50	15x9	M8x90
A168	4~6ℓ	149	189	96	168	50	30x12	M8x90
A220	10~57ℓ	193	235	119	220	60	30x11	M8x90

15. Clamp Band

3 Bladder Type (Carbon Steel)

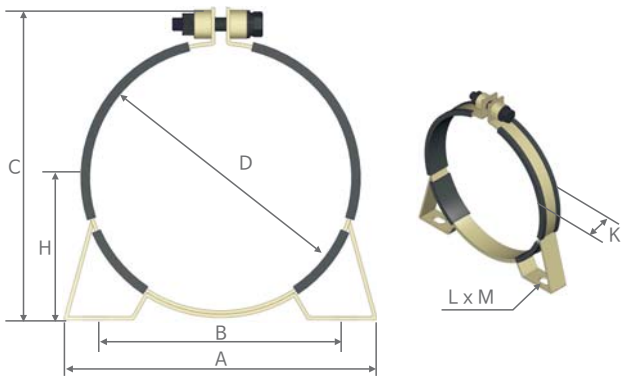


Fig 1

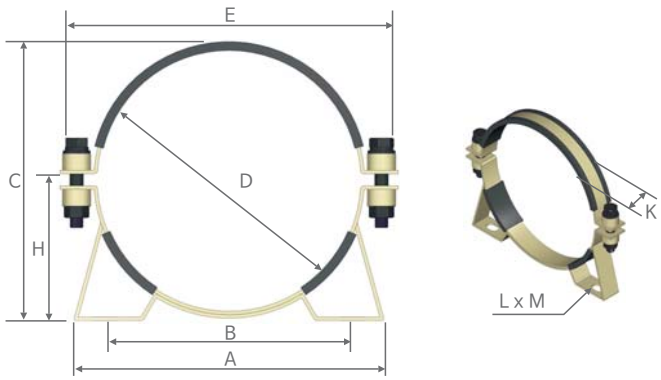


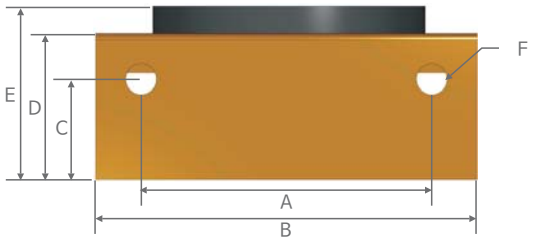
Fig 2

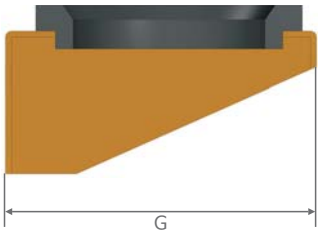
Code	Volume Category	Figure	Dimension (mm)								
			A	B	C	D	E	H	K	L	M
B114	1.0~2.5ℓ	Fig1	138	100	159	114	-	73	30	9	16
C114	1.0~2.5ℓ	Fig2	138	100	138	114	172	73	30	9	16
B168	4~6ℓ	Fig1	188	148	207	172	-	96	30	10	20
C168	4~6ℓ	Fig2	188	148	186	172	230	96	30	10	20
B220	10~57ℓ	Fig1	270	216	268	220	-	125	30	11	20
C220	10~57ℓ	Fig2	270	216	241	220	289	125	30	11	20
B226	10~57ℓ	Fig1	270	216	270	226	-	125	30	11	20
C226	10~57ℓ	Fig2	270	216	244	226	295	125	30	11	20
B230	10~57ℓ	Fig1	270	216	274	230	-	125	30	11	20
C230	10~57ℓ	Fig2	270	216	246	230	299	125	30	11	20

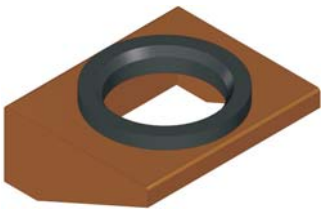
*Please contact FLOWFORCE for more information of the cushion rings for large size accumulators.

16. Support Bracket & Cushion Ring

1 Support Bracket

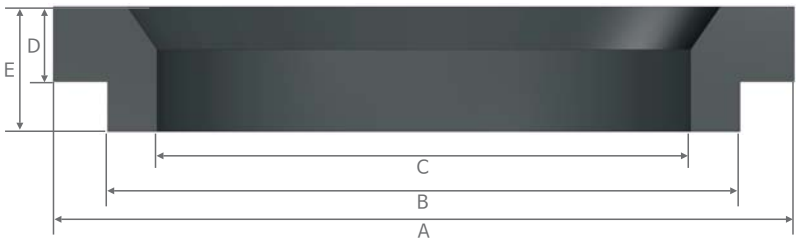






Code	Volume Category	Weight	Dimension (mm)						
			A	B	C	D	E	F	G
SB01	1.0~2.5ℓ	0.8	75	130	35	60	75	13	140
SB02	4~6ℓ	1.5	160	210	55	80	95	17	175
SB03	10~57ℓ	3.8	200	260	75	100	120	17	235

2 Cushion Ring

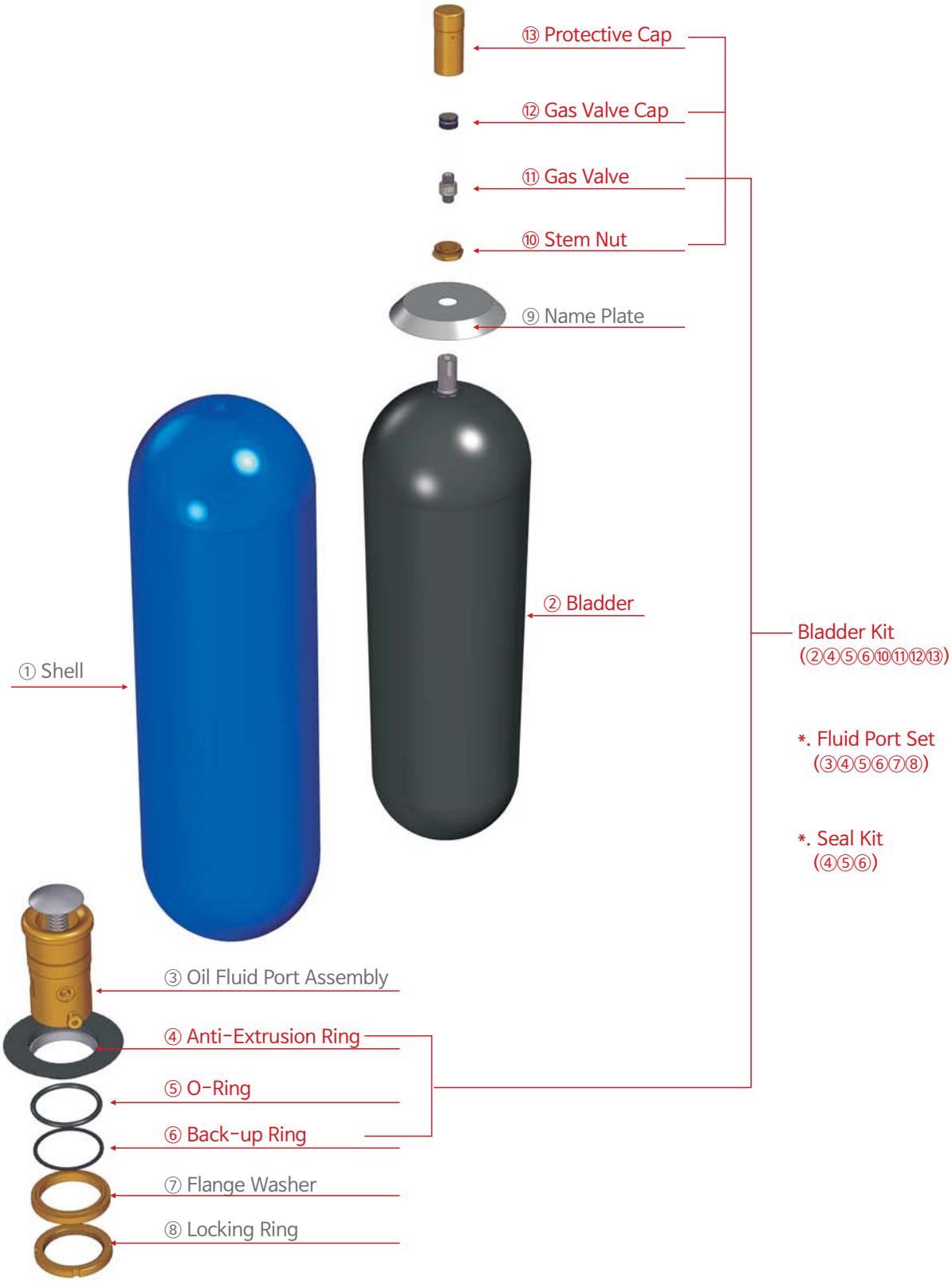


Code	Volume Category	Dimension (mm)				
		A	B	C	D	E
CR01	1.0~2.5ℓ	125	109	89	15	25
CR02	4~6ℓ	150	128	108	15	25
CR03	10~57ℓ	206	165	150	20	30

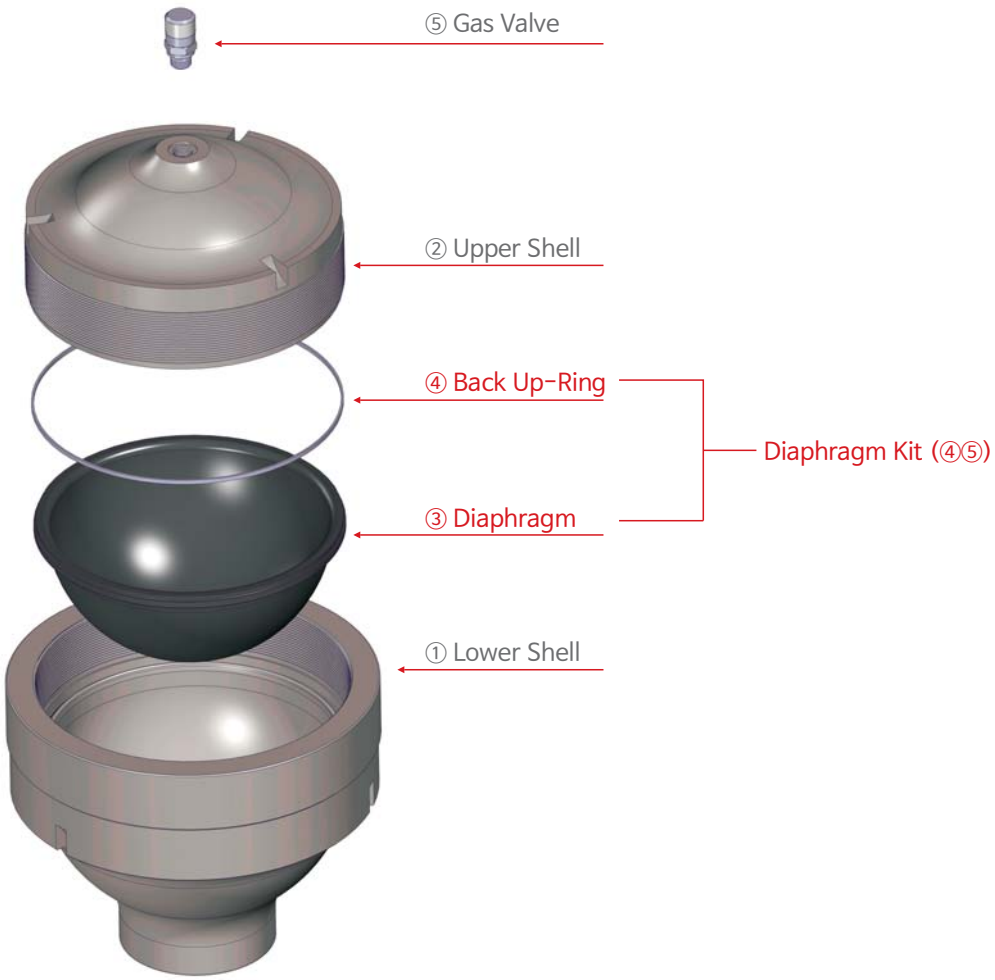
*Please contact FLOWFORCE for more information of the cushion rings for large size and piston accumulators.

17. Accumulator Repair Kit

1 Bladder Type

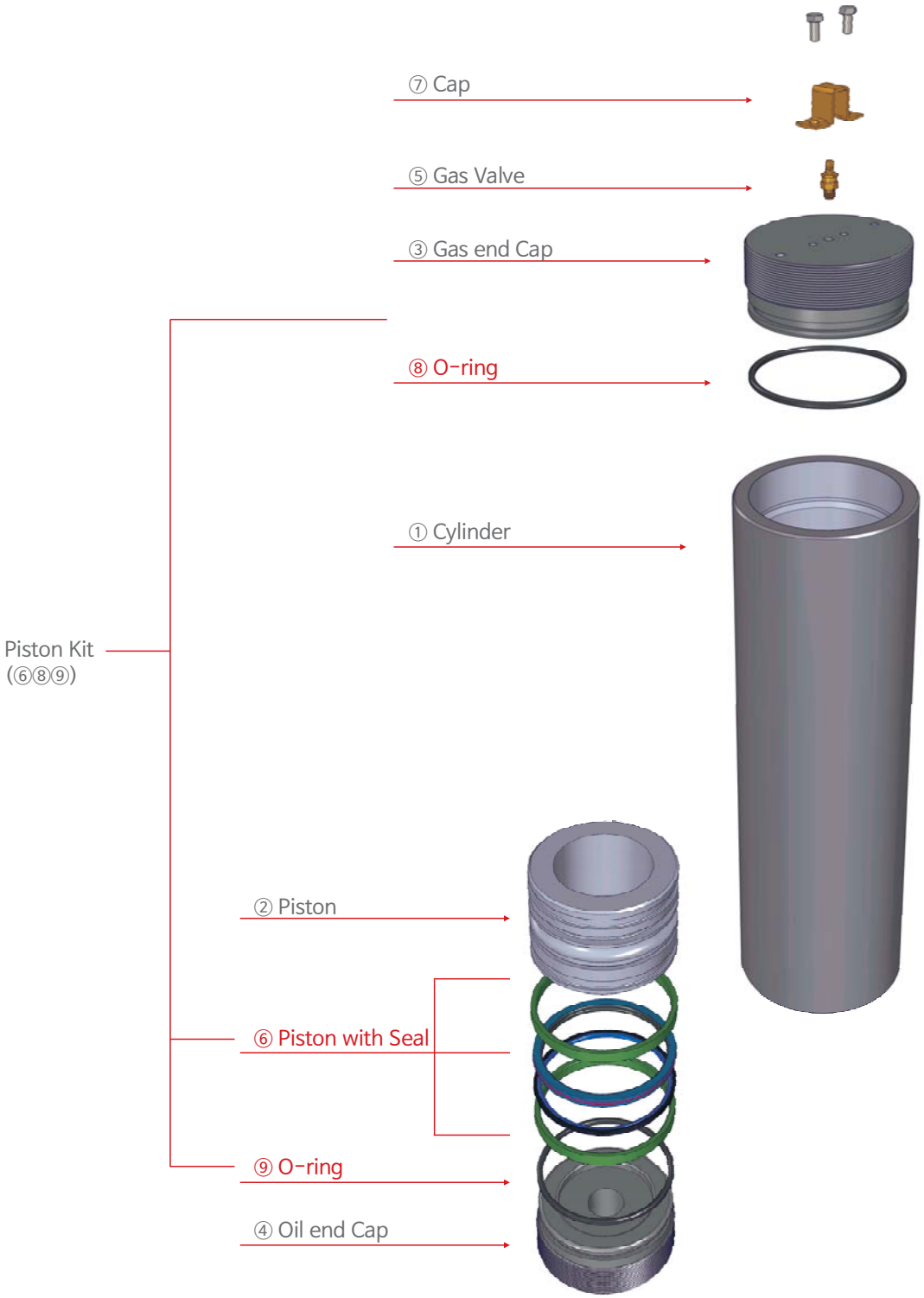


2 Diaphragm (Thread) Type



17. Accumulator Repair Kit

3 Piston Type



18. Accumulator Volume Calculation

1 Method of calculation used by applications and examples

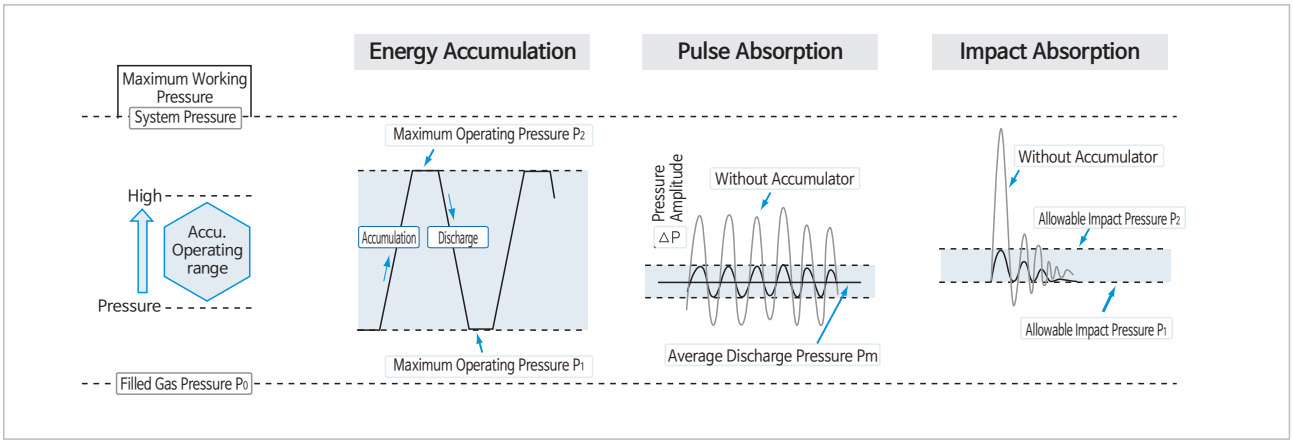
Accumulator volume is basically calculated on the basis of

$P_0V_0 = P_1V_1 = P_2V_2 = C$

although this formula can be varied by applications.

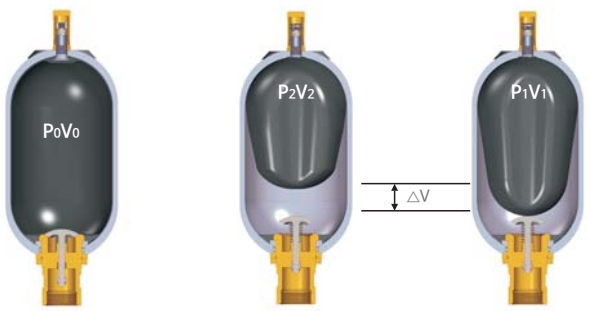
Examples

Terms related to Accumulator pressure



- Max. Working pressure : This pressure is referred to as the maximum working pressure.
- System pressure : The maximum possible pressure of a circuit and generally used to refer to the release pressure of a relief valve mounted on the equipment or machinery.
- Max. Operating pressure (P_2) :Max. applicable pressure at which gas can be compressed.
- Min. operating pressure (P_1) : The Min. pressure when fluid is discharged from the accumulator.
- Filled Gas pressure (P_0) : Seal pressure of N_2 Gas
- Average discharge pressure (P_m) : The average pressure of fluid discharged from the pump, etc.
- Normal pressure (P_1) : The pressure within a pipe with no impact pressure.
- Allowable impact pressure (P_2) : Maximum allowable impact pressure.

Operating Condition of Accumulator



Filled with N_2 gas

Bladder expands and poppet closes

Fluid flow in

When the fluid pressure reaches the filled gas pressure, the poppet opens and accumulation takes place until the pressure reaches the maximum operating pressure

Fluid discharged

Fluid discharges until the minimum operating pressure is reached

Accumulator Volume

P_0	Filled Gas Pressure	V_0	Gas Volume at P_0
P_1	Min. operating pressure	V_1	Gas Volume at P_1
P_2	Max. Operating pressure	V_2	Gas Volume at P_2
n	Polytropic Index (Index determined by temperature and pressure of the gas)		

18. Accumulator Volume Calculation

1 Energy Accumulation

1 Applicable Basic Formula

3 types of following formulas based on the system condition are generally used to calculate for energy accumulation (system pressure / flow compensation).

Calculate the required gas volume (Vo)

① In case of isothermal change, slow accumulation and slow discharge

$$V_0 = \frac{dV \times \frac{P_1}{P_0}}{1 \times \frac{P_1}{P_2}}$$ ▶ Formula ①

② In case of polytropic change (1), quick accumulation and quick discharge

$$V_0 = \frac{dV \times \frac{P_1}{P_0}}{1 - (\frac{P_1}{P_2})^{1/n}}$$ ▶ Formula ②

※ This formular is the most commonly used.

③ In case of polytropic change (2), slow accumulation and quick discharge

$$V_0 = \frac{dV \times \frac{P_2}{P_0}}{(\frac{P_2}{P_0})^{1/n} - 1}$$ ▶ Formula ③

※ Isothermal ≥ 90 seconds of operating time ≥ Polytropic

Basic terms

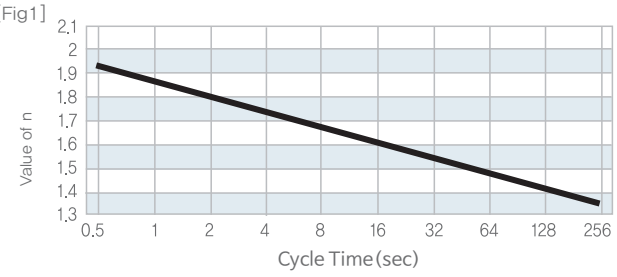
V_0	Accumulator Gas Volume – (ℓ)
dV	Accumulator Necessary Discharge Flow – (ℓ)
P_0	N2 Filled Gas Pressure – (kg/㎠)
P_1	Min. Operating Pressure – (kg/㎠)
P_2	Max. Operating Pressure – (kg/㎠)
n	Polytropic Index

Select the polytropic index (n)

Please refer to the tables below to calculate n of the N_2 gas which are varied to operating time (cycle time), average working pressure and temperature of N_2 gas and ambient.

① Value of n according to the operating time

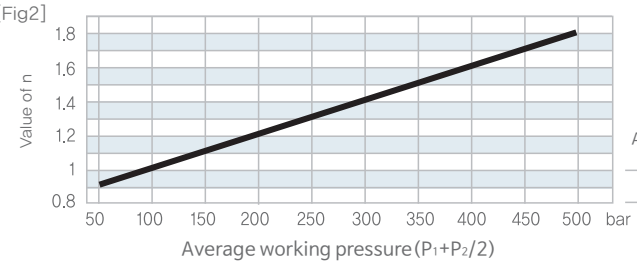
[Fig1]



Operating Time	0.5	1	2	4	8	16	32	64	128	256
Value of n	1.93	1.87	1.8	1.73	1.68	1.62	1.55	1.49	1.42	1.35

② Value of n according to the average working pressure

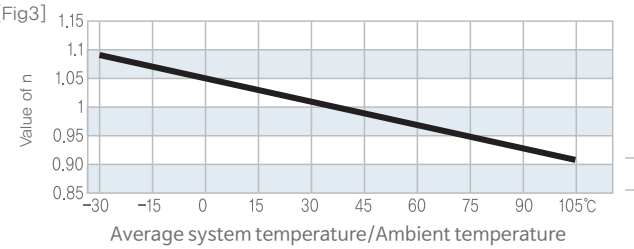
[Fig2]



Average working pressure	10	50	100	150	200	250	300	350	400	450	500
Value of n	0.85	0.92	1.02	1.11	1.21	1.31	1.40	1.50	1.60	1.70	1.79

③ Value of n according to the ambient temperature or average working temperature

[Fig3]



Ambient temperature	−30	−15	0	15	30	45	60	75	90	105
Value of n	1.08	1.07	1.05	1.03	1.01	0.99	0.97	0.95	0.93	0.91

2 Calculation and select the model

[Working Condition & System Specification]

Working Condition & System Specifiçation

P_2 : Max. Operating Pressure = 180kg/㎠ · G

P_1 : Min. Operating Pressure = 120kg/㎠ · G

P_0 : N2 Filled Gas Pressure(at Tmax 50℃) = 102kg/㎠ · G

$$P_1 \times (0.9) \times \frac{Tmin+273}{Tmax+273} = 120 \times 0.9 \times \frac{32+273}{50+273}$$

Q : Discharge per Pump Rotation = 110Liter/min

D : Cylinder Inside Diameter = 280mm

S : Cylinder Stroke = 360mm

V : Cylinder working speed 0.53m/sec.

Fluid = Petroleum-based hydraulic fluids

Working temperature = Tmin 32℃~Tmax 50℃

[Question]

※ What is the appropriate model of accumulator for operating the cylinder under the above working condition?

Solution

1) Find the value of Accumulator Necessary Discharge Flow(dV) firstly based on the above working condition.

$$dV = \frac{\pi XD}{4} \times S \times 10^{-6}$$

$$= \frac{\pi X280}{4} \times 360 \times 10^{-6}$$

$$= 22.16 \text{ Liter}$$

18. Accumulator Volume Calculation

2) Calculate the value of n since it is a polytropic change.

Time of working cycle (accumulation & discharge) : 12.08 + 0.68 = 12.76 sec

Average operating pressure (Pm) $= \frac{P_2 + P_1}{2} = \frac{180+120}{2} = 150 kg/cm^2$

Average working temperature : $(T_{min} + T_{max})/2 = (32+50)/2 = 41℃$

※ The final value of n is verified according to the Fig.1, 2, 3 on page 60~61.
n=1.65 x 1.11 x 1.00 = 1.83

3) Calculate the total volume of the accumulator

$$V0 = \frac{dV(P_1/P_0)}{[1-(P_1/P_2)^{n/1}}$$

$$= \frac{22.16x(120/102)}{[1-(120/180)^{1/1.83}]} = 131.3 Liter$$

4) Find the number of unit according to the above necessary total volume.

131.3 Liter = 131.3 / 50Liter = one of 3 units or 150 Liter accumulator.

5) Verify the Max. Accumulator Discharge Flow whether it is appropriate.

- Time for oil accumulation $(T_1) = \frac{dV}{Q} = \frac{22.16}{110/60} = 12.08 sec$
- Time for oil discharge $(T_0) = \frac{S}{V} \cdot 10^{-3} = \frac{360}{0.53} \cdot 10^{-3} = 0.68 sec$
- $\frac{dV}{T_0} = \frac{22.16}{0.68} \fallingdotseq 32.58 \ell / sec$

According to the above 4), FB 330-14A (3 x 13.5Liter/sec) is enough for the cylinder operation.

6) Select the bladder material: Please see page 19 for detailed material of bladder based on the working temperature.

N :NBR : Buna-n : -15℃~85℃

7) Select the final accumulator model which is suitable for the above conditions from 1) to 6) Refe to page 20, FBN 330-14A is selected.

8) Consider installation and maintenance cost.

※ Technical Note

: How to calculate N_2 Gas filling pressure at ambient temperature (at 20℃)

$$P_0 (at\ 20℃) = P_0 (at\ T_{max}) \times \frac{T_0+273}{T_{max}+273}$$

$$= 102 \times \frac{20+273}{50+273} = 92.5 kg/cm^2$$

When the oil temperature increases in hydraulic system, the pressure increases based on the temperature due to increased molecular activity of N_2 gas.
This example is based on the ambient temperature at 20℃ that automatically maintenance the pressure at 102kg/㎠ at 50℃ of the system temperature when filling N_2 gas pressure at 92.5kg/㎠.

Sizing chart & Calculation for Accumulator Gas Volume

In case of energy storage, the below table which is the pressure ratio between Max. operating pressure and Average operating pressure is much convenience to select the appropriate accumulator model (accumulator gas volume)

[Fig. 4]

Pressure Ratio P_2/P_1>4	Accumulators Size: Standard Bladder Accumulators												Transfer Barrier with 50L Gas Back-Up Bottle Fitted					
P_2/P_1	0.16	0.6	1	3	4	10	20	32	50	57	100	150	28X1	37X1	37X2	54X1	54X2	P_2/P_1
1.05 1.10	0.005 0.010	0.018 0.035	0.035 0.066	0.08 0.14	0.12 0.22	0.29 0.34	0.57 1.09	1.07 2.03	1.49 2.84	1.67 3.17	2.99 5.77	4.80 9.22	2.20 4.18	2.46 4.69	3.87 7.37	2.87 5.49	4.28 8.16	1.05 1.10
1.15 1.20	0.015 0.019	0.049 0.063	0.094 0.120	0.21 0.26	0.31 0.39	0.78 0.98	1.55 1.97	2.90 3.68	4.04 5.13	4.51 5.73	8.32 10.70	13.32 17.14	5.96 7.58	6.73 8.60	10.56	7.88 10.06	11.73 14.97	1.15 1.20
1.25 1.30	0.022 0.026	0.074 0.086	0.143 0.149	0.31 0.36	0.47 0.54	1.17 1.35	2.35 2.69	4.39 5.03	6.12 7.02	6.84 7.85	12.91 14.99	20.68 23.99	9.06	10.20 11.91		11.94 13.94	17.76	1.25 1.30
1.35 1.40	0.029 0.032	0.096 0.104	0.183 0.201	0.40 0.44	0.60 0.66	1.80 1.65	3.01 3.29	5.62 6.16	7.84 8.60	8.76 9.61	16.93 18.73	27.09 29.98		13.11		15.35 16.77		1.35 1.40
1.45 1.50	0.034 0.036	0.113 0.121	0.217 0.231	0.47 0.50	0.71 0.76	1.78 1.90	3.56 3.80	6.65 7.11	9.28 9.98	10.37 11.15	20.45 22.06	32.72 35.29				18.09 19.33		
1.55 1.60	0.038 0.041	0.128 0.135	0.245 0.258	0.53 0.56	0.81 0.85	2.01 2.12	4.03 4.23	7.53 7.89	10.50 11.04	11.74 12.34	23.58 25.02	37.72 40.03						
1.65 1.70	0.042 0.044	0.141 0.146	0.270 0.280	0.59 0.61	0.89 0.92	2.21 2.30	4.43 4.60	8.27 8.60	11.54 12.01	12.90 13.43	26.38 27.67	42.21 44.27						
1.75 1.80	0.046 0.047	0.152 0.157	0.290 0.300	0.63 0.65	0.95 0.98	2.38 2.46	4.77 4.92	8.91 9.20	12.44 12.84	13.91 14.35	28.90 30.07	46.24 48.12						
1.85 1.90	0.048 0.049	0.161 0.165	0.310 0.320	0.67 0.69	1.00 1.04	2.53 2.60	5.06 5.20	9.47 9.71	13.210 13.56	14.77 15.16	31.2 32.26	49.91 51.61						
1.95 2.00	0.051 0.052	0.169 0.173	0.325 0.331	0.71 0.72	1.06 1.09	2.66 2.72	5.32 5.44	9.95 10.17	13.88 14.19	15.51 15.86	33.28 34.26	53.25 54.81						
2.10 2.20	0.054 0.056	0.179 0.186	0.344 0.355	0.75 0.77	1.13 1.17	2.83 2.92	5.56 5.84	10.56 10.91	14.74 15.23	16.47 17.02	36.08 37.77	57.74 60.45						
2.30 2.40	0.057 0.059	0.191 0.195	0.365 0.374	0.80 0.82	1.20 1.23	3.00 3.07	6.00 6.18	11.22 11.49	15.66 16.04	17.51 17.93	39.34 40.78	62.94 65.27						
2.50 2.60	0.060 0.061	0.200 0.203	0.382 0.389	0.83 0.85	1.26 1.28	3.14 3.20	6.28 6.39	11.74 11.95	16.38 16.68	18.31 18.64	42.13 43.39	67.43 69.44						
2.70 2.80	0.062 0.063	0.207 0.210	0.395 0.401	0.86 0.87	1.30 1.32	3.25 3.29	6.50 6.59	12.15 12.32	16.95 17.19	18.95 19.21	44.57 45.68	71.33 73.10						
2.90 3.00	0.064 0.065	0.212 0.215	0.406 0.411	0.88 0.89	1.34 1.35	3.34 3.37	6.67 6.75	12.42 12.61	17.41 17.60	19.46 19.67	46.71 47.70	74.77 76.33						
3.20 3.40	0.066 0.067	0.219 0.222	0.419 0.425	0.91 0.92	1.38 1.40	3.44 3.49	6.88 6.98	12.85 13.04	17.94 18.20	20.05 20.35	49.93 51.52	79.9 82.42						
3.60 3.80	0.068 0.069	0.224 0.227	0.430 0.434	0.94 0.95	1.41 1.43	3.53 3.57	7.06 7.13	13.20 13.33	18.42 18.60	20.59 20.80	52.95 54.24	84.72 86.80						
4.00 4.50	0.070 0.075	0.228 0.231	0.437 0.443	0.96 0.97	1.44 1.46	3.59 3.64	7.18 7.28	13.43 13.61	18.98 18.98	20.95 21.22	55.44	88.70						

Example 1

What size of accumulator will discharge 1.4L of liquid between the Max. working pressure at 140kg/㎠ and Min. working pressure at 120kg/㎠?

SOL

① $P_2/P_1 = \frac{140}{120} = 1.17$

② Find the value of P_2/P_1 which is equal to or next lowest to 1.17. In this case the value is 1.15.

③ Select accumulator reference equal to or next greater to 1.4 from the values located in the row 1.15.
Thus, total necessary volume of accumulator is 20 ℓ.

④ Select the accumulator model by FBN 330-5A.

※ Accumulator Necessary Discharge Flow is according to the pressure ratio of P_1/P_2 ($P_0 = P_1 \times 0.9$)

[Note]

① The above table is based on the following formulars.

- P_2 = Max. System Pressure
- P_1 = Min. System Pressure
- $P_0 = P_1 \times 90\%$
- $P_0V_0 = P_2V_2$ = Isothermal compression
- $P_2V_2^n = P_1V_1^n$ = Adiabatic expansion
- n = 1.4

② Ensure to use the above table, when the value of V_0-V_2 is within 80%.

18. Accumulator Volume Calculation

2 Pulsation Dampener

1 Applicable Basic Formula

There is a pulse from the pump when the pressurized fluid discharged. Pulse produces noise and vibrations that make the system as instability and the components are being damaged. Following formular is to minimize the vibration for the double acting that the pressure pulsation is varied by the number of piston and RPM.

$$\therefore V_0 = \frac{AKL(P_1/P_0)\ 1/n}{1-(P_1/P_2)\ 1/n}$$

Basic terms

V_0	Accumulator Gas Volume
P_0	N_2 Filled Gas Pressure
P_1	Average Pump Discharge Pressure
P_2	Max. Pump Working Pressure (Max. Allowable Pressure Pulsation)
A	Pump Cylinder Area
L	Pump Stroke
K	Value of Constant (K) based on Pump type
n	Polytropic Index 1.4 (N_2 Gas)

Constant (K) for Pump Type

Number	Type of Pump	K
1	Single-acting	0.60
	Double-acting	0.25
2	Single-acting	0.25
	Double-acting	0.15
3	Single-acting	0.13
	Double-acting	0.06
4	Single-acting	0.10
	Double-acting	0.06
5	Single-acting	0.06
	Double-acting	0.02
6	(Gear Pump)	0.06
7	(Vane Pump)	0.02

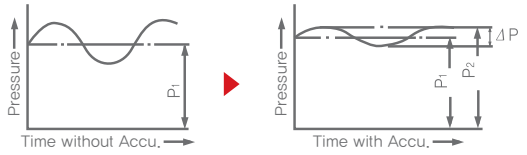
In case of Gear Pump

$$K = 0.6 \cdot A \cdot L \frac{\text{Pump Discharge (cc/min)}}{\text{(RPM) x No. of Gear}}$$

$$\text{Ripple Factor} = \frac{P_2-P_1}{P_1} \times 100\%$$

Calculation for Max. Allowable Pressure Pulsation

$$P_2 = P_1 + \frac{\Delta P}{2} \text{ or } P_2 = \left(1+\frac{\text{Target Ripple Factor (\%)}}{100}\right) \times P_1$$



2 Calculation and select the model

What is the appropriate accumulator volume to reduce the pulsation from the pump under the working condition below?

- **Pump Type** : Triple Double-acting Plunger Pump
- **Inside Diameter of Plunger** : 100mm(10cm)
- **Average Discharge Pressure** : 170kg/㎠
- **Plunger Stroke** : 180mm
- **Target Ripple Factor** : 3%
- **System Temperature** : Tmin = 10℃
  Tmax = 50℃,

$$(P_1 \times (0.65 \sim 0.75) \times \frac{Tmin+273}{Tmax+273}$$

$$\fallingdotseq 170 \times 0.7 \times \frac{10+273}{50+273} \fallingdotseq 105 kg/㎠$$

[Solution]

① P_0 = 105kg/㎠(P1 x 0.6~0.75)
P_1 = 170kg/㎠
P_2 = 170+(170x0.03)=175.1kg/㎠
K = 0.06(Refer to page 64)
A $= \frac{\pi D2}{4} = \frac{3.14 \times 10^2}{4} = 78.5㎠$
L = 180mm(18cm)
n = 1.4

② **Accoring to the calculation of accumulator,**

$$V_0 = \frac{AKL(P_1/P_0)^{1/n}}{1-(P_1/P_2)^{1/n}}$$

$$= \frac{78.5 \times 18 \times 0.06 \times (170/105)^{1/1.4}}{1-(170/175.1)^{1/1.4}}$$

$$= 5.727㎥$$

$$\fallingdotseq 5.8 ℓ$$

③ **Set the Bladder volume based on applicable fluid**
Nominal capacity of the accumulator that the gas volume is 6ℓ and it goes to the model of **FLOWFORCE** Accumulator as FBN330-1.5A with N_2 Gas filling pressure at 105kg/㎠(Refer to page 18)

18. Accumulator Volume Calculation

3 Surge Pressure

1 Applicable Basic Formula

① **Determine the surge pressure**

When rapid closure of valve or sudden load changes in hydraulic system, there is an impact pressure in pipe lines which can lead to noise or damages to pipes or internal parts.

Surge pressure is generated when the speed of fluid is zero within closing time of valve(T) or the distance between the pipe ends is less than the time it takes to the road speed of sound pressure waves.

$$TC \leq \frac{2L}{\alpha}$$

T : Valve Closing Time(sec)
L : Length of Pipe(m)
α : Speed of the shock wave(m/sec)
TC : Critical Time: Round Trip Time of α

$$\alpha = \sqrt{\frac{k \cdot g}{r} / \left(1+\frac{k \cdot d}{eE}\right)} \times 10$$

② **Appropriate accumulator volume is selected by the formular below.**

$$\therefore\ V_a = \frac{W \times V^2 \times (n-1)}{200 \times P_0\left(\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right)}$$

Working Condition & System Specification

V_0	Accumulator Gas Volume(ℓ)
W	Total weight of fluid(kg)
V	Fluid Velocity(m/sec)
g	Gravitational acceleration(9.8m/sec^2)
L	Pipe Length(m)
P_0	Filled Gas Pressure(kg/㎠), P_1=(0.6~0.8xP_2)
P_2	Max. Allowable Impact Pressure(kg/㎠)
P_1	Normal Pressure or Initail System Pressure(kg/㎠)
n	Polytropic Index, 1.4

2 Calculation and select the model

What is the appropriate accumulator volume for following working condition(T=0.1 sec)?
Pipe Length = 120m
Pipe Size = 6B, SCH 40
Line Pressure before closing = 14kg/㎠·g
Flow = 3200 ℓ /min
Water Temperature = 15 ~ 20℃(Tmin: 15℃ ~ Tmax: 20℃)

[Solution]

① ・Specific weight of water(γ) = 1000kg/㎥
・Pipe Length(L) = 120M
・Pipe Size(d) = 151.0mm(6B. SCH40 Copper)
・Flow(Q) = 3200ℓ/min
・Fluid Velocity(V) = $21.23 \cdot Q/d^2 = 21.23 \times 3200/151^2$)
= 2.98m/sec
・Total weight of fluid(W) = $\frac{\pi \cdot d}{4} \cdot L \cdot \gamma 10^6$
= $\frac{\pi \cdot 151}{4}$ x120x1,000x10^6
= 2148kg
・Normal Pressure(P_1) = 14kg/㎠

② **Check the possibility of the surge pressure in pipelines**

・Speed of the shock wave(α) = $\sqrt{\frac{k \cdot g}{\gamma} / (1+\frac{k \cdot d}{eE})}$ x10

여기서,
・Bulk modulus of water(k)=2.083x10^4 kg/㎠
・The modulus of longitudinal elasticity of the pipe material(E)=2.1x10^6kg/㎠
・Pipe thickness(e)=7.1mm
※ Thus,

・$\alpha = \sqrt{\frac{2.083x10^4 x9.8}{10}} / (1+\frac{2.083x10^4 x151}{2.1x10^6 x7.1})$ x10

≒ 1302m/sec
・Critical Time(TC) = $\frac{2xL}{\alpha} = \frac{2x120}{1302}$ =0.18sec
So, there is surge pressure occurred because T(0.1 sec) is less than TC(0.18 sec)

③ **Max. Allowable Surge Pressure goes to P_2 〈 1.1 · P_1**

・P_2 = 14×1.1≒16kg /㎠.a
・P_0 = $P_1 \times (0.6 \sim 0.75) \times \frac{T_{min}+273}{T_{max}+273}$
= 16 0.67 $\frac{15+273}{20+273}$
= 10.5kg/㎠·abs(N_2 Gas filling pressure)

④ **The necessary gas volume of accumulator is,**

$\therefore\ V_a = \frac{W \times V^2 \times (n-1)}{200 \times P_0 ((\frac{P_2}{P_1})^{\frac{n-1}{n}} - 1)}$

$= \frac{2148 \times 2.98^2 \times (1.4-1)}{200 \times 10.5 \times ((\frac{16}{14})^{\frac{1.4-1}{1.4}} - 1)}$

⑤ $V_o = V_a \times \frac{P_1}{P_0}$

$V_o = 95 \times (\frac{14}{10.5}) = 126$ ℓ

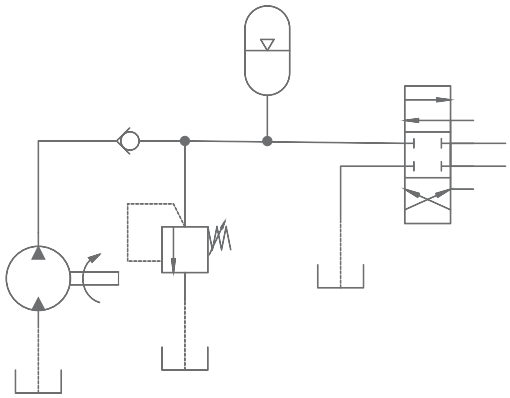
⑥ **Select the appropriate model**

Set the bladder material: Refer to page 19. for bladder material based on fluid and working temperature.
Model Code of selected accumulator : FLN-50-40A, 1EA(Refer to page 23)
(Gas volume 50x3-150 ℓ >126 ℓ)
The calculation of N_2 gas filling pressure is the surge pressure under ambient temperature.

18. Accumulator Volume Calculation

Question (1)

There might be shocks generated when the direction of the flow is changed using a solenoid valve on a hydraulic line. What is the appropriate model of accumulator for the surge pressure concerning below hydraulic circuit?



- Pipe Diameter (d) = 3/4"B SCH 160 (I.D : 16.2mm)
- Pipe Length (L) = 16M
- Flow Rate (Q) = 240 ℓ /Min
- Normal Pressure (P_1) = 150kg/㎠
- Max. Allowable Impact Pressure (P_2) = 150 × 1.1 ≒ 165kg/㎠
- N_2 Gas filling pressure (P_0) $= P_1 \times (0.6 \sim 0.75) \times \frac{T_{min}+273}{T_{max}+273}$

  $= 165 \times (0.65) \times \frac{40+273}{50+273}$

  $= 105 kg/㎠.g$
- Specific weight of fluid (γ) = 900kg/㎥

  (Hydraulic oil type: Phosphate ester hydraulic fluid, Working Temperature at Tmin: 40 ~ Tmax: 50℃)

[Solution]

(1) $W = \frac{\pi d}{4} \cdot L \cdot \gamma \cdot 10^{-6}$

$= \frac{\pi \times 16.2}{4}$ 16 900 10^{-6}

$= 2.96 kg$

(2) According to the accumulation calculation,

$V_0 = Va \times \frac{P_1}{P_0}$

$V_0 = \frac{W \cdot V \cdot (n-1)}{200 \cdot P_0 \cdot [(P_2/P_1)^{n-1/n} - 1]}$

$= \frac{2.96 \times 19.42 \times (1.4-1)}{200 \times 105 \times [(165/150)^{1.4-1/1.4} - 1]}$

$\fallingdotseq 0.8 ℓ$

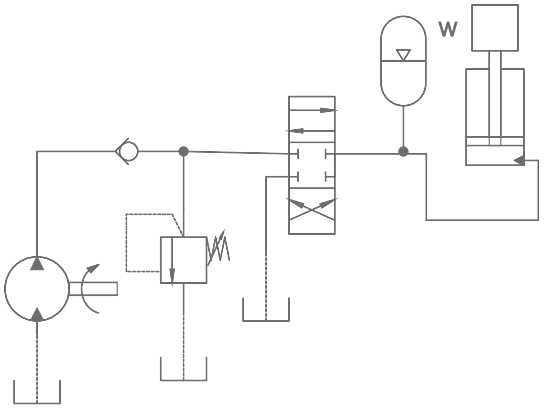
$V_0 = 0.8 \times \frac{150}{105} = 1.1 ℓ$

(3) Select the appropriate model

- Set the bladder material: Refer to page 19. for bladder material based on fluid and working temperature.
- Model Code of selected accumulator FBN 350-0.7A, 1EA (Gas volume 2.5 ℓ 〉1.1 ℓ)

Question (2)

There might be shocks generated by sudden stop or descent of Ram from the constant speed and pressure.
What is the accumulator volume to abosrb this impact pressure?



- Ram Weight (Load, W) = 800ton
- Normal Pressure (P_1) = 120kg/㎠
- Ram Rate Descent (V) = 0.12sec
  (Hydraulic oil type: Phosphate ester hydraulic fluid, Working Temperature at Tmin: 40 ~ Tmax: 50℃)

[Solution]

(1) Max. Allowable Impact Pressure (P_2) = 120 x 1.1=132kg/㎠

- N_2 Gas filling pressure (P_0) $= P_1 \times (0.75) \times \frac{T_{min}+273}{T_{max}+273}$
  $= 120\ 0.72\ \frac{40+273}{50+273}$
  $= 84 kg/㎠.g$
- Flow Rate (Q) = It can safely be ignored because the flow rate is very small.

(2) According to the accumulation calculation,

$$Va = \frac{W \times V \times (n-1)}{200 \times P_0 ((\frac{P_2}{P_1})^{\frac{n-1}{n}} - 1)}$$

$$= \frac{800 \times 10 \times 0.12 \times (1.4-1)}{200 \times 84 ((\frac{132}{120})^{\frac{1.4-1}{1.4}} - 1)}$$

$$= 8\ \ell$$

$$V_0 = Va \cdot \frac{P_1}{P_0} = 8 \times \frac{120}{84} = 9.1\ \ell$$

(3) Select the appropriate model

- Set the bladder material: Refer to page 19. for bladder material based on fluid and working temperature.
- Model Code of selected accumulator : FBV 330-2.5A 1EA (Gas volume 10 ℓ〉9.1 ℓ)

18. Accumulator Volume Calculation

4 Thermal Expansion Compensator

1 Applicable Basic Formula

Both the fluid and the pipes will expand in volume when the fluid is heated up in the pipes of the closed circuit.
The coefficient of thermal expansion of the fluid which is unstable condition is greater than the coefficient of thermal expansion of the piping material.
Morevoer, thermal expansion of the fluid increases all the pressure in the whole system.
This pressure which is instability increasing is unnecessary and damages on the expensive hydraulic components.
Increase or decrease of the internal pressure occurs due to the temperature changes in a closed circuit. It is also one of the accumulator functions that reduce the fluctuations in the pressure.

$$\therefore V_0 = \frac{V_1 (T_2 - T_1)(\beta - 3\alpha)(P_1/P_0)}{1 - (P_1/P_2)}$$

Basic terms

V_0	Accumulator Gas Volume (ℓ)
P_0	N_2 Gas Filled Gas Pressure (P_1 X 0.7 ~ 0.8) (kg/㎠ abs)
P_1	Min. System Pressure at T_1 (kg/㎠ abs)
P_2	Max. System Pressure at T_2 (kg/㎠ abs)
V_1	Total Amount of Fluid in Pipes at T_1 (Pipe Cross-sectional Area x Pipe Length) ℓ
T_1	Initial System Temperature (℃) : Absolute Pressure (abs) (273+℃) = Tmin
T_2	Increased System Temperature (℃) : Absolute Pressure (abs) (273+℃) = Tmax
α	Coefficient of Linear Expansion Piping (1/℃)
β	Coefficient of Volume Expansion of Fluid (1/℃)
n	Polytropic Index, 1.4

2 Calculation and select the model

[Question] What is the appropriate accumulator volume based on the working condition below?

- Pipe Length : 15M
- Bore Area of Pipe : Φ125(SCH40)
- Material : Steel
- Specific weight of fluid(γ) : 0.75(at 20℃)
- Fluid : Gasoline

[Solution]

(1) ・V_0 : Accumulator Gas Volume

・$P_0 = P_1 \times (0.8 \sim 0.9) \times \frac{T_{min}+273}{T_{max}+273}$

$= 1.73 \quad 0.9 \quad \frac{293}{328}$

$= 1.4 kg/㎠ \cdot abs$

・P_1 : 0.7+1.033=1.73kg/㎠·abs

・P_2 : 4+1.033=5.03kg/㎠·abs

・$T_2 - T_1$: 328−293=35℃

・Φ125(SCH40) Total volume of Φ125(SCH40) pipe
O.D(Outside of Diameter) of Steel Pipe: 139.8mm, Thickness of Steel Pipe: 6.6mm

$Vt = \frac{\pi(139.8-2 \quad 0.66)^2}{4} \quad 1{,}500cm$

$= 188.725㎤$

$= 189Liter$

・α: 10 10^{-6} 1/℃ (from Engineering Hand Book)

・β: 13.5 10^{-4} 1/℃ (Gasoline)

(2) Thus, necessary gas volume is,

・$V_0 = \frac{V_t(T_2-T_1)(\beta-3\alpha)(P_1/P_0)}{1-(P_1/P_2)}$

・$V_0 = \frac{189 \quad (35) \quad (13.5 \quad 10^{-4}-3 \quad 10^{-6}) \quad (1.73/1.4)}{1-(1.73/5.03)}$

≒ 15.3Liter

(3) Select the appropriate model

- Set the bladder material: Refer to page 19. for bladder material based on fluid and working temperature.
- Model Code of selected accumulator FBN 330−5A, 1EA

※ Note : Please see example on page 61 for the calculation of N_2 gas filling pressure at ambient temperature.

19. Accumulator Selection Request

Please fill in the blank and send it by email(master@flowforce.co.kr) or fax(+82-31-499-9886). Date: / /

Company / Dept.	/			
Contact Information	Person		Tel	
	e-mail		Fax	
System Information	Name of system			
	Location			
Application		Ex. Energy accumulation / Pulse absorption / Impact absorption / Others		
Type of Accu.	☐ Bladder Type ☐ Diaphragm Type ☐ Piston Type			

1. Working Condition

Location	☐ Indoor ☐ Outdoor	Operating time required of system	____Hour/Day	Installation	☐ Vertical ☐ Horizontal ☐ Other
Temperature Condition	Fluid Temp : ~ ℃ Normal Temp : ℃	Applicable Fluid	☐ Common Mineral Oil		
	Ambient Temp : ~ ℃ Normal Temp : ℃		☐ Others		
Material	**Shell** ☐ Carbon Steel(standard) ☐ SUS ☐ Other( ) **Bladder** ☐ NBR(standard) ☐ Viton ☐ EPDM ☐ Other( )				
	Any other specific required( )				

2. Operating Condition

☐ Energy Accumulation

Max. Operating Pressure	P_2	bar
Min. Operating Pressure	P_1	bar
Necessary Discharge Flow	△V	ℓ
Charge/Discharge Period		sec
Required Discharge Flow	q	ℓ/min

"※. System Pressure = Max. Working Pressure(P2) = Relief Valve Opening Pressure"

☐ Pulse Absorption

Average Discharge Pressure(pump)		P_1	bar
Target Ripple Factor		-	%
Pump Specification	Discharge	Q	ℓ/min
	Rotations	N	rpm
Type of Pump		☐ Plunger ☐ Cylinder	
		☐ Diaphran ☐ Single ☐ Double	
		☐ Vane ☐ Gear	

☐ Impact Absorption

Normal Pressure	P_1	bar
Allowable Impact Pressure	P_2	bar
Fluid Density	ρ	kg/㎥
Inside Pipe Diameter	d	mm
Pipe Length	L	m
Flow Rate	Q	ℓ/min
Flow Velocity	V	m/s

※ Other application	☐ Thermal Expansion Compensation	☐ Leak Compensation	☐ Gas Spring	☐ Transfer Barrier
	☐ Equilibrium Action	☐ Other		

3. Option

Fluid Port Connection		Gas Port Connection	
☐ Unnecessary		Permanent Gauge	☐ Unnecessary
☐ Bushing	Size:		☐ Necessary
☐ Flange	Connection Diameter: A		☐ Fuse Met
	☐ A _____ Type	TR Cap (Temp. sensing type)	☐ Unnecessary
	☐ B _____ Type		☐ Necessary
	☐ C _____ Type	Pressure Guage	☐ b
	☐ Other		☐ Other
Regulation	☐ CE MArk ☐ ASME		
	☐ China Requlation(SELO) ☐ Other		

4. Additional Specification

Nameplate	☐ Standard	Manufacturer Specification
	☐ Customized	Other:
Paint	☐ Manufacturer Standard	
	(· Coat : · Topcoat : · Color :)	
	Designated	
Internal Cleanliness	☐ Manufacturer Standard	Nas 10 Class
	☐ Designated	Nas_____Class
Filled N_2 Gas Pressure	☐ Standard	20bar
	☐ Designated	_____bar at _____℃
Other		

Result of Selection	Type		Model / code	
	Quantity	EA	Filled N_2 Gas Pressure	_____bar at _____℃

20. Accumulator Calculation Sheet

1 Energy Accumulation

Date : / /

Company name		Equipment or Machinery	
Person in charge / Dept.		Installation Position	☐ Vertical ☐ Horizontal ☐ Other_____

Working Condition

Working Temperature	Fluid Temp.	– ℃	Fluid Type	☐ Fluid :
	Ambient Temp.	– ℃		☐ Other :

Max. Operating Pressure	P_2	bar	Max. pressure of accumulated fluid in the accumulator
Min. Operating Pressure	P_1	bar	Min. pressure when fluid is discharged from the accumulator
Average Operating Pressure	Pm	bar	Pm = (P_2+P_1) / 2
Necessary Discharge Flow	dV	ℓ	Total amount of fluid required for piston(actuator) operation
Accumulation/Discharge Cycle Time	Tc	sec	Tc = △tm(Accumulation time) + △tn(Discharging time)

Calculate necessary gas volume (V_0)

Less than the pressure at 10bar is calculated as an absolute pressure(Absolute Pressure=Pg + 1.0339)

☐ Set Filled N_2 Gas Pressure (P_0)	☐ If no changes in temperature takes place : P_0=(0.8~0.9)xP_1	0.85x( ) = _____ bar
	☐ If the temperature changes : $P_0 = \frac{273+T\,min}{273+T\,max} \times (0.8\sim0.9) \times P_1$	$\frac{273+(\quad)}{273+(\quad)}$ x 0.85xP_1=_____bar
	Max. N_2 Gas Charging ($\alpha = P_0/P_2$)	• Vertical mounting : 1/4($P_0 \geq P_2$ x 0.25) • Horizontal mounting : 1/3($P_0 \geq P_2$ x 0.33)
☐ Set Polytropic Indices(n)	① Cycle Time x ② Average Operating Pressure x ③ Average ambient temperature = n	
	n = ( ) Cycle Time x ( ) Average Operating Pressure x ( ) Average ambient temperature = _____	※ Please refer to the graph for the curve 1, 2 and 3 on page 60~61.

☐ Calculate Necessary Gas Volume for Accumulator(Vo)

$$\therefore V_0 = \frac{dV \times (P_1/P_0)}{1-(P_1/P_2)^{1/n}} = \frac{(\quad)(\quad/\quad)}{1-(\quad/\quad)^{1/(\quad)}} = \_\_\_\_\_\ \text{Liter}$$

Verify Necessary Discharge Flow Q max Qmax = dV x 60 ÷ △tn = ( ) x 60 ÷ ( ) = _____ ℓ /min

Select Accumualtor Model

※ Please refer to the specification on page 20~26 for the accumulator gas volume (V_0)

- Select the model according to P_2, Qmax
- Select the bladder material according to the fluid and temperature.
- Select the steel parts(shell, port) according to the fluid
- Select the correct size of fluid port and gas connection

Model Code	Liter / Gas Volume
– –	_____ ℓ

※ No. of necessary accumulators
= V_1_____ ℓ /(Accumulator Gas Volume)/ _____ ℓ /unit

Verify the discharge flow(△V) of the selected accumulator

$$\therefore \triangle V = V_0(\text{Gas Volume}) \times \frac{1-(P_1/P_2)^{1/n}}{P_1/P_0} = (\quad) \times \frac{1-(\quad/\quad)^{1/(\quad)}}{(\quad/\quad)} = \frac{(\quad)}{(\triangle V \geq dV)}\ \text{Liter}$$

20. Accumulator Calculation Sheet

2 Pulse Absorption

Date : / /

Company name		Equipment or Machinery	
Person in charge / Dept.		Installation Position	☐ Vertical ☐ Horizontal ☐ Other_____

Working Condition

Working Temperature		Fluid Temp.	- ℃	Fluid Type	☐ Fluid :
		Ambient Temp.	- ℃		☐ Other :
System Pressure	P max	bar	Max. possible pressure applied to the accumulator in the circuit. (Release pressure of the relief valve)		
Average Discharge Pressure	P_1	bar	Average pressure of fluid discharged from the pump		
Target Ripple Factor		%			
Type of Pump: ☐ Plunger / ☐ Diaphragm / ☐ Gear / ☐ Vane / ☐ Other	Number		☐ Single-acting ☐ Double-acting		
Pump Specification	Discharge	ℓ /min			
	Rotation	rpm			

K - Pump Type

Type of Pump		K	
	No.	Single-acting	Double-acting
Plunger	1	0.60	0.25
	2	0.25	0.15
	3	0.13	0.06
	4	0.1	0.06
	5	0.06	0.02
	6	0.06	
	7 or more	0.02	
Gear / Vane		0.06	

Calculate Necessary Gas Volume (V_1)

Less than the pressure at 10bar is calculated as an absolute pressure (Absolute Pressure=PG + 1.0339)

☐ Set Constant (k)	Refer to the above table, K-Pump Type	
☐ Set Filled N_2 Gas Pressure (P_0)	☐ If no changes in temperature takes place : $P_0=(0.6\sim0.75)\times P_1$	x 0.7=_____bar
	☐ If the temperature changes : $P_0=\frac{273+T\ min}{273+T\ max}\times(0.6\sim0.75)\times P_1$	$\frac{273+(\quad)}{273+(\quad)}$ x 0.7=_____bar
	Max. N_2 Gas Charging ($\alpha=P_0/P_2$)	· Vertical mounting : $1/4(P_0 \geq P_2 \times 0.25)$ · Horizontal mounting : $1/3(P_0 \geq P_2 \times 0.33)$
☐ Calculate Discharge per Pump Rotation (Q)	☐ Q = Discharge ÷ Rotation = ( ) ( ) = _____ ℓ /Rotation	
☐ Set Polytropic Indices (n)	n = 1.40 (N_2 Gas)	
☐ Max. Operating Pressure (P_2)	P_2 = (1+Target Ripple Factor/100) x P_1	= 1 + ( )/100 = ( )bar

☐ Calculate Necessary Gas Volume for Accumulator (V_0)

$$\therefore V_0 = \frac{Q \times K \times (P_2/P_0)^{1/n}}{1-(P_1/P_2)^{1/n}} = \frac{Q \times K \times (\quad/\quad)^{1/1.4}}{1-(\quad/\quad)^{1/1.4}} = \_\_\_\_\_\ Liter$$

Select Accumualtor Model

※ Please refer to the specification on page 20~26 for the accumulator gas volume (V_0).

- Select the model according to V_0, Pmax
- Select the bladder material according to the fluid and temperature.
- Select the steel parts (shell, port) according to the fluid
- Select the correct size of fluid port and gas connection

Model Code	Liter / Gas Volume
- -	_____ ℓ

※ No. of necessary accumulators
= V_1_____ ℓ / (Accumulator Gas Volume) / _____ ℓ /unit

3 Impact Absorption

Date : / /

Company name		Equipment or Machinery	
Person in charge / Dept.		Installation Position	☐ Vertical ☐ Horizontal ☐ Other_____

Working Condition

Working Temperature	Fluid Temp.	– ℃	Fluid Type	☐ Fluid :
	Ambient Temp.	– ℃		☐ Other :

System Pressure	P max	bar	Max. possible pressure applied to the accumulator in the circuit (Release pressure of the relief valve).
Allowable Impact Pressure	P_2	bar	$P_2 = P_1 + \alpha$(110% x P_1) / Generallt set to be 110% of the normal pressure
Normal Pressure	P_1	bar	The pressure within a pipe with no impact pressure.
Fluid Density	τ	kg/㎥	Water: 1,000kg/㎥ (Petroleum based hydraulic oil: 900kg/㎥, Phosphate ester: 1,100kg/㎥)
Inside Pipe Diameter	d	mm	
Pipe Length	L	m	
Flow Rate	Q	ℓ /min	
Flow Velocity	v	m/s	Flow rate = Pipe diameter

Calculate necessary gas volume(V_1)

Less than the pressure at 10bar is calculated as an absolute pressure(Absolute Pressure=PG + 1.0339)

☐ Calculate Fluid Mass within the Line(W)	$W = \pi/4 \times d^2 \times L \times \tau \times 10^{-6}$	$= \pi/4 \times (\quad)^2 \times (\quad) \times (\quad) \times 10^{-6} =$ ____ kg
☐ Calculate Flow Velocity(v)	$v = 21.33 \times Q/d^2$	$= 21.33 \times (\quad)/(\quad)^2 =$ ____ m/s
☐ Set Filled Gas Pressure(P_0)	☐ If there are no changes in temperature : $P_0 = (0.6 \sim 0.8) \times P_1$	x 0.7=_____bar
	☐ If the temperature changes : $P_0 = \frac{273+T\,min}{273+T\,max} \times (0.6 \sim 0.8) \times P_1$	$\frac{273+(\quad)}{273+(\quad)}$ x 0.7=_____bar
	Max. N_2 Gas Charging ($\alpha = P_0/P_2$)	· Vertical mounting : 1/4($P_0 \geq P_2$ x 0.25) · Horizontal mounting : 1/3($P_0 \geq P_2$ x 0.33)
☐ Set Polytropic Indices(n)	n = 1.40	(Nitrogen Gas)
☐ Allowable Impact Pressure(P_2)	$P_2 = 1.1 \times P_1$	$= 1.1 \times (\quad) =$ _____ bar

☐ Calculate Accumulator Gas Volume(V_A) when Pressure is (P_1)

$$\therefore V_A = \frac{W \times V^2 \times (n-1)}{200 \times P_0 \times (P_2/P_1)^{n-1/n} - 1} = \frac{(\quad) \times (\quad)^2 \times (1.4-1)}{200 \times (\quad) \times (\quad)/(\quad)^{1.4-1/1.4} - 1} = \_\_\_\_\_ \text{ Liter}$$

☐ Calculate Necessary Gas Volume for Accumulator(V_0)

$$\therefore V_0 = V_A \times \frac{P_1}{P_0} = (\quad) \times \frac{(\quad)}{(\quad)} = \_\_\_\_\_ \text{ Liter}$$

Select Accumualtor Model

※ Please refer to the specification on page 20 for the accumulator gas volume(V_0).

- Select the model according to V_1, Pmax
- Select the bladder material according to the fluid and temperature.
- Select the steel parts(shell, port) according to the fluid
- Select the correct size of fluid port and gas connection

Model Code	Liter / Gas Volume
– –	_____ ℓ

※ No. of necessary accumulators
= V_1_____ ℓ /(Accumulator Gas Volume)/ _____ ℓ /unit

20. Accumulator Calculation Sheet

4 Thermal Expansion Compensation

Date : / /

Company name		Equipment or Machinery	
Person in charge / Dept.		Installation Position	☐ Vertical ☐ Horizontal ☐ Other_____

Working Condition

Working Temperature	Fluid Temp.	- ℃	Fluid Type	☐ Fluid :	
	Ambient Temp.	- ℃		☐ Other :	

System Operating Condition				
Max. Operating Pressure	P_2	bar	Pressure at Temperature T_2	
Normal Pressure	P_1	bar	Pressure at Temperature T_1	
Filled N_2 Gas Pressure	P_0	bar		
Initial System Temperature	t_1	℃		
Increased System Temperature	t_2	℃		
The coefficient of thermal expansion based on the pipe material	α	1/℃	$\alpha = 10 \times 10^{-6}$ 1/℃ (Steel)	
Fluid volume expansion coefficient	β	1/℃	Refer to Fluid volume expansion coefficient below.	
Necessary Gas Volume	V_1	ℓ	Volume at T_1	

Calculate necessary gas volume (V_0)

Less than the pressure at 10bar is calculated as an absolute pressure (Absolute Pressure=Pg + 1.1013)

☐ Set Filled N_2 Gas Pressure (P_0)	☐ If no changes in temperature takes place : $P_0=(0.6\sim0.8)\times P_1$	x 0.7=_____bar
	☐ If the temperature changes : $P_0=\frac{273+T\,min}{273+T\,max}\times(0.6\sim0.8)\times P_1$	$\frac{273+(\quad)}{273+(\quad)}$ x 0.7=_____bar
	Max. N_2 Gas Charging ($\alpha=P_0/P_2$)	· Vertical mounting : $1/4(P_0 \geq P_2 \times 0.25)$
		· Horizontal mounting : $1/3(P_0 \geq P_2 \times 0.33)$

☐ Calculate Necessary Gas Volume for Accumulator (Vo)

$$\therefore V_o = \frac{V_1 \times (T_1-T_2)\times(\beta-3\alpha)\times(P_1/P_0)}{1-(P_1/P_2)} = \frac{(\quad)\times(\quad)-(\quad)\times(\quad)-3(\quad)\times(\quad)/(\quad)}{1-(\quad)/(\quad)} = \_\_\_\_\_ \text{ Liter}$$

※ Fluid volume expansion coefficient

Fluid Density	0.86~0.87	0.87~0.88	0.88~0.89	0.89~0.90	0.90~0.91	0.91~0.92	0.92~0.93	0.93~0.95	0.95~0.96	0.96~0.97
① Cubic expansion coefficient	0.00077	0.00076	0.00075	0.00074	0.00073	0.00072	0.00071	0.0007	0.00069	0.00068
② Fluid ensity	0.97~0.98	0.98~1.00	1.001~1.075							
③ Cubic expansion coefficient	0.00067	0.00066	0.00063							

Select Accumualtor Model

※ Please refer to the specification on page 20~26 for the accumulator gas volume (V_0)

- Select the model according to V_1, Pmax
- Select the bladder material according to the fluid and temperature.
- Select the steel parts (shell, port) according to the fluid
- Select the correct size of fluid port and gas connection

Model Code	Liter / Gas Volume
- -	

※ No. of necessary accumulators
= V_1_____ ℓ / (Accumulator Gas Volume) / _____ ℓ /unit

21. Accumulator Handling & Precaution

Before installation

1. Please ensure to check the nameplate of the accumulators whether they match to your order.
2. Never use the accumulators at pressure above its maximum working pressure.
3. Please do not use any other types of fluids than the selected fluids.
   (It will be caused deterioration of the product life-cycle)
4. The accumulators are not filled with N_2 gas when they are shipped to customers and ensure to fill N_2 gas before using the accumulators.
   (Pre-filling at 2 bar only, but N_2 gas filled as per customer request when placing the order)

Installation & N_2 Gas Charging

5. Before installation of accumulators, please ensure to use clamp band to fix the accumulators.
6. Ensure not to operate accumulators prior to filling of N_2 gas. It is caused to damage to bladders.
7. Ensure to fill the accumulators with only N_2 gas.

- **Never use oxygen or inflammable gas.**
- **Ensure not to use air instead of N2 gas that the life-cycle of bladders will be shortened.**

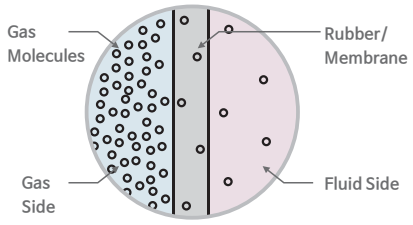
8. Prior to checking N_2 gas pressure, ensure to release the fluid pressure.
9. Before releasing the fluid pressure, please ensure to utilize by-pass or drain positioned between main pipe.

Operation & Maintenance

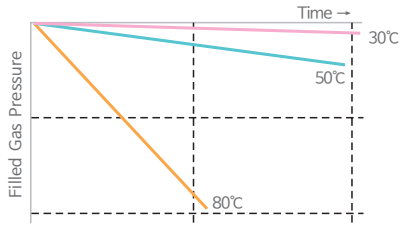
10. Carry out the periodic maintenance and inspections of the accumulators approximately 2 times per year.
    ① Add more N_2 gas if it is insufficient.

※ Note that N_2 gas will typically permeate from the bladders causing the gas pressure to drop
(Please refer to Technical Manual for more information about osmotic pressure and precautions).

Gas Permeation



Relationship between temperature of accumulator and pressure drop in filled gas pressure



② Ensure to check the leakage for any external N_2 gas or fluid.
③ Ensure to check accumulators for any damages, loosened screws or any abnormalities.

11. Ensure to release the pressure in system line prior to disassembling accumulators.
12. Ensure to release all N_2 gas from the accumulators prior to storage.
13. Before disposing of accumulators, please ensure to completely remove N_2 gas first then, remove gas valve and control valve, thereby ensuring not to use again.

※ Please note
- Ensure to adequate ventilation of the room when removing N_2 gas from accumulators
  (The room might become saturated with N_2 gas and will lead to a deficiency of oxygen).
- Welding or any other process of accumulators are strictly prohibited.

Please contact FLOWFORCE or nearest service center regarding any necessary on-site gas filling or replacing parts.

21. Accumulator Handling & Precaution

1 N_2 Gas Charging Kit

FCU charging kit allows the customers to fill N_2 gas safely and check the gas pressure in accumulators on a regular basis.

One of the main features of the regulator as an option that controls the supplied pressure of N_2 gas stably and safely.

This FCU charging kit is durable and easy-to-use structure designed.

1.1 Safety Instruction and Precautions.

1. Before using this FCU charging kit, please ensure to read the safety instructions and precautions.
2. We are not responsible for the product defaults occurred using any other tools and kits during charging N_2 gas.
3. In order to prevent any damages on bladders before N_2 charging, please ensure to release oil pressure first.
4. Purity of the N_2 gas is always more than 99.8%.
5. Please ensure to use the regulator when setting the charging kit for pressure charging.
6. FCU charging kit is a test tool.
7. After using the charging kit, please release the charging kit from the accumulators.

1.2 Application

Bladder Type Accumulator
Piston Type Accumulator
Diaphragm Type Accumulator
Membrane Type Accumulator
Others

1.3 Appropriate charging pressure

Energy accumulation	: 80~90% of minimum operating pressure
Surge absorption	: 60~80% of normal pressure
Thermal expansion compensation	: 60~80% of normal pressure
Pulse absorption	: 60~75% of the average operating pressure

2 Accumulator Handling & Precaution

Recommendation : Please refer to the instruction manual before proceeding start-up charging process.

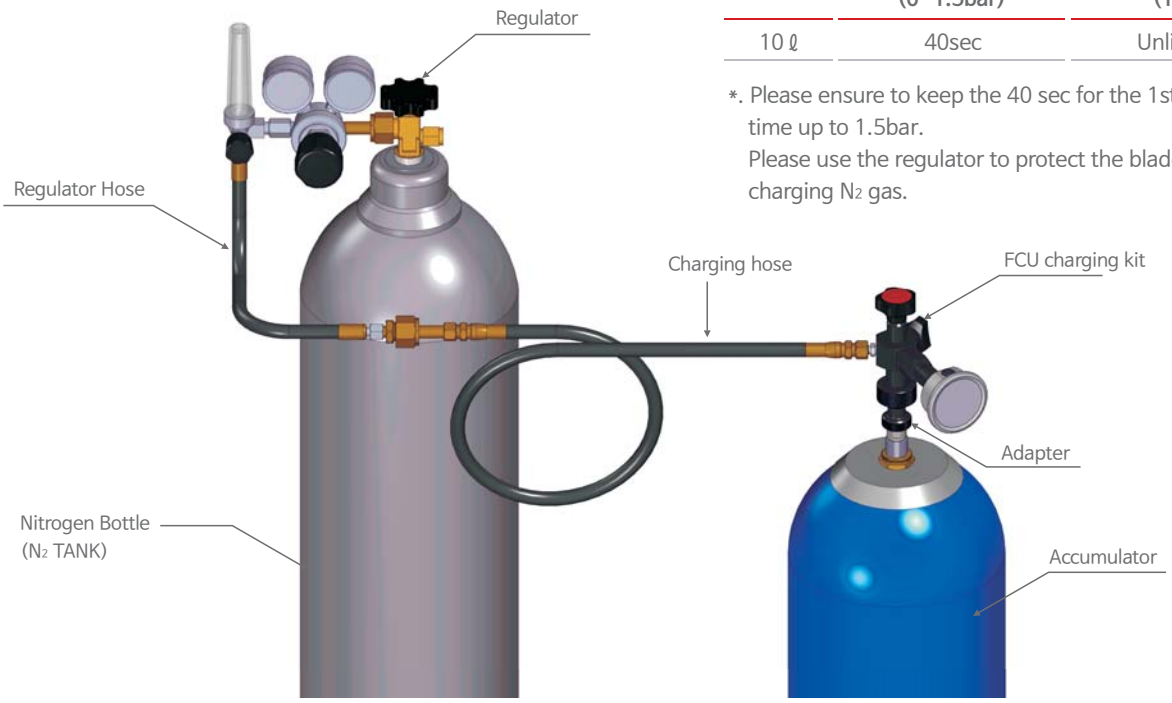
Pressure limitation : Please check the maximum pressure of each accumulator that described on the shell. After filling N_2 gas, please wait for a while until the pressure is stabilized that it needs a certain time of period for N_2 gas pressure to be stabilized.

Depending on the ambient temperature when filling N_2 gas, it is necessary to control and adjust the amount of N_2 gas.

※. Charging management based on Volume
Ex) Membrane Accu.

Volume	1st Charging Time (0~1.5bar)	2Charging Time (1.5~)
10ℓ	40sec	Unlimited

*. Please ensure to keep the 40 sec for the 1st charging time up to 1.5bar.
Please use the regulator to protect the bladders when charging N_2 gas.



Regulator features

In case of initial charging, please ensure to use low pressure in a certain time(If the initial charging pressure is high when charging the accumulator might be damaged to the bladders due to the sudden expansion)

At this time, a constant pressure control is necessary during the initial filling of N_2 gas by the regulator.

1. To be filled up to 10bar by using the regulator.
2. Connector the charging hose to N_2 gas tank and fill N_2 gas up to desired pressure.

21. Accumulator Handling & Precaution

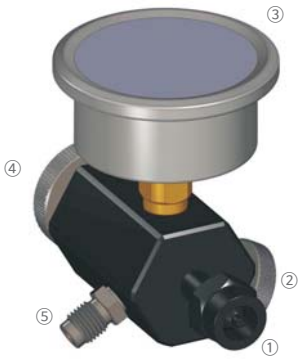
3 N_2 Gas Charging Process

1st step : Be Ready

1. Please ensure to determine the optimal pressure
   (In order to prevent damages on the bladders, bladder type accumulators should be filled with more than 25% and Diaphragm type accumulators should be filled with more than 17%).
2. Connecting Charging hose
   - First, connect the regulator to the N_2 gas tank.
   - In case of using only charging kit, then connect the N_2 gas tank with the charging kit.
3. Connecting charging kit
   Using the adapters to connect between the charging kit and gas valve.

Part list

① Charging Device Nozzle
② Air Vent Valve
③ Pressure Gauge
④ Charging Handle
⑤ Tank Valve Nipple



2nd step: Check N_2 Gas Pressure

4. Open the inlet bolt of gas valve.
   - In case of Diaphragm accumulators, open the inlet bolt a bit. (35N 90°: Too much open will be happened leakage)
5. Please ensure to check N_2 gas pressure from the accumulators by turning the knob(④) as counterclockwise.
6. Please check whether N_2 gas supplying to the accumulator turning the knob(②) as clockwise a bit.
7. If see there is the pressure of the accumulator, then filling N_2 gas to the accumulator.

3rd step: N_2 Gas Charging

8. Open the N_2 gas tank.
9. In case of charging N_2 gas pressure by using regulator, please set up the desired pressure first.
10. Please stop charging the pressure by turning the knob(④) as clockwise when the pressure of the gauge is slightly above the desired pressure.
11. Close the valve of N_2 gas tank.
12. Close by turning the knob(②) as clockwise, and release the residual pressure of charging kit.
13. When the pressure is stabilized, please re-check the pressure whether it is pressurized. Then, disassemble the charging kit from the accumulator.

4th step : Final Check-up

14. Please do the leak test by using soapy water on gas valve of the accumulator.
    * If there is no leakage found on Diaphragm type accumulator, close the gas valve by torque wrench.
15. Close the cover after removing the soapy water.

* How to adjust N_2 gas pressure is to connect the charging kit with the accumulator while open the knob(④), check the pressure gauge until desired pressure by turning the knob(②). After disassemble the charging kit, do the leak test by soapy water.

22. Appendix

1. Length

mm	cm	m	in
1	0.1	0.001	0.0394
25.4	2.45	0.0245	0.965

2. Pressure

Mpa	kg/㎠	bar	psi
1	1.01972	10	145.038
0.09807	1	0.98067	14.2233
0.1	10.1972	1	14.5038
0.00689	0.07031	0.06895	1

3. Volume

Liter	IN^3	U.S.gal	U.K.gal
1	61.033	0.264	0.219
0.016	1	0.004	0.003
3.785	231	1	0.833
4.546	277.419	1.2	1

4. Viscosity & Kinematic Viscosity

Pa.S	cp	P
1	$1 X 10^3$	1 X 10
$1 X 10^{-3}$	1	$1 X 10^{-2}$
$1 X 10^{-1}$	$1 X 10^2$	1

m/s	cSt	St
1	$1 X 10^6$	$1 X 10^4$
$1 X 10^{-6}$	1	$10 X 10^{-2}$
$1 X 10^{-4}$	$1 X 10^2$	1

5. Temperature

℃	℉	℃	℉
-40	-40	+80	+176
-20	-4	+100	+212
0	+32	+120	+248
+20	+68	+140	+284
+40	+104	+160	+320
+60	+140	+180	+356

MEMO

MEMO